BS 7121-5:2006

BRITISH STANDARD

Code of practice for safe use of cranes –

Part 5: Tower cranes

ICS 53.020.20

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Contents

Summary of pages

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Foreword

Publishing information

This part of BS 7121 was published by BSI and came into effect on 28 April 2006. It was prepared by Subcommittee MHE/3/11, *Crane safety and testing*, under the authority of Technical Committee MHE/3, *Cranes and derricks*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This part of BS 7121 supersedes BS 7121-5:1997, which is withdrawn.

Relationship with other publications

The Lifting Operations and Lifting Equipment Regulations (LOLER) [1] and the Provision and Use of Work Equipment Regulations (PUWER) [2] came into force on the 5 December 1998. Details of the Regulations, an Approved Code of Practice plus HSE guidance can be found in the HSE books *Safe use of lifting equipment* [3] and *Safe use of work equipment* [4].

BS 7121-1 provides general recommendations for crane types not covered in an additional part of BS 7121. BS 7121-2 covers in-service inspection, thorough examination and, where appropriate, testing for the safe use of all types of crane. Subsequent parts of BS 7121 deal with the specific crane types as follows:

- Part 3: Mobile cranes;
- Part 4: Lorry loaders;
- Part 5: Tower cranes;
- Part 6: Derrick cranes;
- Part 7: Overhead/under-hung travelling and goliath cranes;
- Part 8: High pedestal and portal jib dockside cranes;
- Part 9: Container handling cranes;
- Part 10: Rail mounted cranes;
- Part 11: Offshore cranes;
- Part 12: Recovery vehicles and equipment;
- Part 13: Hydraulic gantry lifting systems;
- Part 14: Side boom pipelayers.

When all parts of BS 7121 have been published, CP 3010 will be withdrawn and BS 5744 will be revised to cover manually operated and light cranes only.

Information on the background to the development and use of BS 7121 since the initial publication of BS 7121-1 in 1989 is given in Annex E.

The BS 7121 series has been accepted as representing the consensus of practical experience for safety on cranes.

Information about this document

This new edition represents a full revision of the standard. It is intended to be used in conjunction with other parts of BS 7121 to ensure, so far as is reasonably practicable, that lifting operations are carried out safely.

The Health and Safety Executive (HSE) commends the use of this British Standard to those who have duties under the Health and Safety at Work etc. Act 1974 [5]. This standard was drawn up with the participation of HSE representatives and will be referred to in relevant HSE publications.

Use of this document

As a code of practice, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Any user claiming compliance with this British Standard is expected to be able to justify any course of action that deviates from its recommendations.

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

Presentational conventions

The provisions in this standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is “should”.

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

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1 Scope

This part of BS 7121 gives recommendations for the safe installation and use of tower cranes, including self-erecting tower cranes.

Subjects covered include selection of tower cranes, planning the installation (including site specific design work, e.g. base and ties), erection, extension (including climbing), thorough examination (including testing), maintenance, operation, and dismantling, as well as safety measures to be taken during the execution of all the above functions. It also covers the appropriate selection and training of personnel involved in the safe installation and use of tower cranes.

NOTE Self-erecting tower cranes have been addressed briefly in this document. It is envisaged that a full treatment will be given in a future publication.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 7121 (all parts), *Code of practice for the safe use of cranes*

BS 7671:2001, *Requirements for electrical installations – IEE Wiring Regulations – Sixteenth edition*

BS EN 13586, *Cranes – Access*

[16] HSE Guidance Note GS 6, *Avoidance of danger from overhead power lines.* Sudbury: HSE Books, 1997

[22] HSE Guidance Note HS G 118, *Electrical safety in arc welding*. Sudbury: HSE Books, 1994

3 Terms and definitions

For the purposes of this part of BS 7121, the following terms and definitions apply.

3.1 appointed person
person with the training, practical and theoretical knowledge and experience required to comply with **4.3**

3.2 carrier
device that supports persons during lifting and lowering

NOTE This may also be known as a "manrider".

3.3 climbing
increasing or decreasing the tower height of a crane using a means other than another crane

3.4 competent engineer
person who has such theoretical knowledge and experience of the design of the lifting equipment as enables them to assess the design of tower crane bases, ties and supporting structure connections, together with the adequacy of supporting structures to take the loads imposed by the crane

3.5 competent person
person who has such practical and theoretical knowledge and experience of the crane and the equipment used in the lifting operation as is necessary to carry out the function to which the term relates in each particular context

3.6 crane coordinator
person who plans and directs the sequence of operations of cranes to ensure that they do not collide with other cranes, loads and other equipment (e.g. concrete placing booms, telehandlers, piling rigs)

3.7 crane operator
person who is operating the crane for the purpose of positioning loads or erection of the crane

NOTE Sometimes referred to as "crane driver".

3.8 crane supervisor
person who controls the lifting operation, and ensures that it is carried out in accordance with the appointed person's safe system of work

3.9 employing organization
person or organization who requires a lifting operation to be carried out and is responsible for safe use of the crane

NOTE In the case of a hired crane the degree of the employing organization's responsibility for the safe use of the crane depends on whether the crane is being supplied under a crane hire contract or a part of a contract lift. See Clause ***5****.*

3.10 erector
person trained and assessed in tower crane erection, working under the supervision of an erection supervisor

3.11 erection supervisor
person in control of a team of tower crane erectors on site, who is a senior erector with sufficient experience and additional skills to enable them to supervise, and take responsibility for, the team

3.12 indicator
device which provides warnings and/or data to facilitate the competent control of the crane within its design parameters

3.13 installation
group of activities associated with the erection, alteration and dismantling of a tower crane

3.14 lifting
any movement of loads or persons that includes a change of height

3.14.1 basic lift
lifting operation where the weight of the load(s) can be simply established, and there are no hazards or obstructions within the area of the operation

3.14.2 standard lift
lifting operation where there are hazards, either within the working area of the crane or on the access route to the working area

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3.14.3 complex lift
lifting operation which includes cranes using load enhancement equipment, lifting of persons or when the lifting operation is at a location with exceptional hazards

NOTE An example of a location with exceptional hazards is a chemical plant.

3.15 lifting equipment
work equipment (crane) for lifting or lowering loads, including attachments used for anchoring, fixing or supporting the load

3.16 load
weight which is lifted by the crane

NOTE If cranes are used to lift loads from water, the load could also include forces due to water flow or suction.

3.17 lifting accessory
equipment from which the load can be suspended

NOTE Also known as accessories for lifting.

3.18 method statement
document produced by the appointed person to describe how the crane installation or lifting operation is to be carried out

3.19 radius
horizontal distance between the point at which the axis of rotation meets the ground and the vertical centreline passing through the hook

NOTE For non-slewing cranes, the horizontal distance from the centreline of the hook to the centreline of the nearest bogie or axle, bogie or track, measured at ground level, can be assumed to be the radius.

3.20 radius indicator
device that shows the radius at which the crane is operating

3.21 rated capacity
load that the crane is designed to lift for a given operating condition (e.g. configuration, position of the load)

NOTE The rated capacity was formerly known as "safe working load".

3.22 rated capacity indicator/limiter
RCI/L
device that warns of the approach to overload and prevents the crane from being overloaded as described in BS EN 12077-2

NOTE This was previously known as an "automatic safe load indicator" (ASLI) and "overload protection". For information on ASLIs see BS 7262.

3.23 senior erector
erector with sufficient experience and additional skills to enable them to work with and directly oversee a trainee erector

3.24 service conditions

3.24.1 in-service
condition where the crane is handling loads not exceeding the rated capacities within permissible wind speeds and other conditions as specified by the manufacturer

3.24.2 out-of-service
condition where the crane is either not required for use or is out of use, without a load on the hook and in conditions as specified by the manufacturer

NOTE These conditions may include a higher wind speed than that permitted for the in-service conditions.

3.25 signaller
person responsible for directing the crane operator to ensure safe movement of the crane and load

3.26 slinger
person responsible for attaching and detaching the load to and from the crane, for correct selection and use of lifting accessories in accordance with the specifications of the appointed person and for initiating the movement of the load

3.27 thorough examination
examination by a competent person in such depth and detail as the competent person considers necessary to enable them to determine whether the equipment being examined is safe to continue in use

NOTE The thorough examination is not part of the maintenance regime for the equipment but provides owners with information which could be used to determine the effectiveness of the regime. The competent person may require supplementary tests as part of thorough examination. See BS 7121-2.

3.28 tower crane

3.28.1 conventional tower crane
slewing jib type crane with jib located at the top of a vertical tower which is assembled on site from components

3.28.2 self-erecting tower crane
SETC
jib type crane with jib located at the top of a vertical slewing tower which is a pre-assembled unit transported to site and deployed from its travelling configuration for use

3.29 trainee erector
person undergoing training in the erection of cranes and working at all times under the direct supervision of a senior erector

3.30 use
<of work equipment> activity of any kind involving work equipment

NOTE This includes starting, stopping, programming, setting, transporting, repairing, modifying, servicing and cleaning.

3.31 user
person or organization that has control of the lifting operation and the crane operator, and has a responsibility to ensure that cranes are properly maintained and thoroughly examined by a competent person

3.32 weight
vertical force exerted by a mass as a result of gravity

3.33 zoning device
electromechanical/electronic device to control the area in which a tower crane works

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4 Management of installation and lifting operations

4.1 Safe system of work

A safe system of work should be established and followed for every crane installation operation or lifting operation whether it be an individual lift or a group of repetitive operations. The same principles should be applied when the operations are carried out at a temporary site, for example construction, or when the crane is a permanent fixture, for example in a factory or at a dock.

The safe system of work should include:

a) planning of the operation;

b) selection, provision and use of a suitable crane(s) and work equipment;

NOTE Crane specifiers have a duty to ensure that cranes are selected with adequate capacity for the intended use. Crane users have a duty to ensure that the crane is only used for its intended purpose.

c) any necessary preparation of a site and erection and dismantling of the crane(s);

d) maintenance, examination and where necessary testing of the crane(s) and equipment;

e) the provision of properly trained and competent personnel who have been made aware of their relevant responsibilities under the Health and Safety at Work etc. Act 1974 [5] and supporting regulations;

f) adequate supervision by properly trained and competent personnel having the necessary authority;

g) ensuring that all necessary reports of thorough examination and other documents including the manufacturer's manuals are available;

h) preventing unauthorized movement or use at all times;

i) the safety of persons not involved in the installation or lifting operation.

The safe system of work should be communicated to all parties concerned.

It is essential for the safety of the operation to ensure that all personnel can communicate clearly in the same language.

Cranes are work equipment and it is essential that they are not used for the lifting of persons for entertainment purposes, including joyriding, bungee jumping and stunts.

4.2 Control of the installation or lifting operation

4.2.1 General

In order to implement the safe system of work effectively, one person should be appointed to have overall control of the installation/lifting operation to act on behalf of the management of the employing organization requiring the load to be moved. The appointment of the person does not remove any legal responsibility from the management but enables them to use the appointed person's expertise the better to fulfil their responsibilities. The person appointed may have other duties and need not be an employee of the employing organization. The appointed person should have adequate training and experience to enable these duties to be carried out competently.

On large construction sites where multiple lifting operations are carried out by various subcontractors, the principal contractor should appoint the appointed person for the site. Each of the sub-contractors on site may employ individuals who have undergone appointed person training but they should remain sub-servant to the principal contractor's appointed person. The principal contractor's appointed person should ensure that the crane coordinator is advised of all lifting operations in order that they may perform their duties.

4.2.2 Selection and assessment of appointed person

*NOTE To assist in selection of an appointed person, some examples of lifting operations that require different levels of expertise, training and experience, and that impose different duties on the appointed person, are given in **4.3**. Details of the requirements for installation operations are given in Clause **12** and Clause **13**.*

When selecting an appointed person the employing organization should take into account the variety and complexity of the operation, as well as all the problems that could arise from proximity hazards and environmental courses. The appointed person should be notified formally in writing of their appointment. The appointed person should be given authority to carry out the duties involved, including consulting others with specialist knowledge and experience, and should be able to delegate duties and tasks for any part of the safe system of work to suitably qualified individuals.

The employing organization should review and assess the performance of the appointed person periodically. Different installation/lifting operations might entail selection of a new appointed person, as appropriate, or provision of additional training to the existing appointed person.

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4.2.3 Avoidance of collisions

On sites where there is a possibility of collision between cranes and other equipment the crane coordinator (see **7.2.3**) should plan the sequence of crane movements to prevent collisions. Any corresponding instructions from the crane coordinator to the crane operators should be given via the respective signallers. In such circumstances the signallers should obtain the agreement of the crane coordinator before carrying out any operation.

The positioning of the crane and components in the out-of-service condition, as specified by the manufacturer's instructions, should be such that no collisions can take place, see **14.6**b). This activity should be part of the initial planning process.

4.3 Duties of the person appointed to control the installation/lifting operation

4.3.1 General

The appointed person's duties should include the following.

a) Being familiar with the relevant parts of the project Health and Safety Plan where the lifting operation is being carried out on a site where the Construction (Design and Management) Regulations [6] apply.

b) Assessing the installation/lifting operation to provide such planning, selection of crane(s), lifting accessories and equipment, instruction and supervision as is necessary for the task to be undertaken safely. This may include consultation with other responsible bodies if necessary and ensuring that, where different organizations are involved, they collaborate as necessary.

c) Ensuring that adequate inspection/examination and maintenance of the equipment has been carried out. For further information see BS 7121-2.

d) Ensuring that there is an effective procedure for reporting defects and incidents and taking any necessary corrective action.

e) Taking responsibility for the organization and control of the installation/lifting operation.

f) Ensuring that the crane supervisor is fully briefed on the contents of the method statement (see **6.3**).

The appointed person should be given the necessary authority for the performance of all these duties and, in particular, authority to stop the operation whenever they consider that danger is likely to arise if the operation were to continue.

Duties, but not responsibilities, may be delegated to another person where considered appropriate.

NOTE As the crane operator is required to be at the controls of the crane when it is handling loads, it would not be appropriate to appoint the operator to be in control of the lifting operation. For a basic lifting operation, the management of the employing organization may consider it appropriate to appoint the slinger to be in control of the lifting operation.

The duties of appointed persons for crane operations can vary according to the complexity of the operation. The duties for a basic lift are considerably fewer and less demanding than for a lift at a hazardous location. An appointed person employed for a basic lift might not be suitably trained or experienced for a more complicated operation, and another appointment could be required for this. The information given in **4.3.2** to **4.3.4** can be used so that an appropriate appointment is made and a suitable method statement produced for each lifting operation. The requirement for an appointed person with appropriate training and experience also applies to installation operations.

4.3.2 Basic lift

If the weight of the load(s) can be simply established, and there are no hazards or obstructions within the area of the operation, then the duties of the appointed person should include the following.

a) Establishing the weight of the load. This can be by a reliable source of information, weighing the load, or calculation (with allowance for possible inaccuracies).

   NOTE If cranes are used to lift loads from water, the load could also include forces due to water flow or suction and the effect of loss of buoyancy.

b) Selection of the crane, based on the weight of the load, including the crane hook block and any lifting tackle; the maximum height of lift and the maximum radius required. The rated capacity of the crane should be specified by the manufacturer in the information for use supplied with the crane, or else on the current report of thorough examination issued by the competent person. Manufacturer's sales leaflets should not be relied on for the rated capacity for a specific crane.

c) For self-erecting tower cranes consideration of the location of the operation, taking into account the access and egress required for the crane, and the suitability of the ground to take the loads imposed on the crane during preparation for the lift and during the lift itself. Lifting operations involving self-erecting tower cranes should take into account the recommendations given in Annex A.

d) Ensuring that the crane is not operated in wind speeds in excess of those given in the instruction manual for the crane. Consideration should also be given to the wind area of the load to ensure that its movement in the wind does not present a hazard.

e) Ensuring that the crane has been thoroughly examined at least within the previous 6 months (for lifting of persons) or 12 months (including testing where appropriate), inspected and checked before use.

f) Ensuring that a system for reporting defects is in place.

g) Selecting appropriate lifting accessories, including their method of attachment to the load, and any protection used to prevent damage.

h) Ensuring that lifting accessories are thoroughly examined, at least within the previous 6 months, inspected and checked before use.

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i) Designating a person to check the lifting accessories and any lifting points that are provided on the load to ensure they are free from any obvious defect before attaching the load to the crane.

j) Briefing all persons involved in the lifting operation to ensure that the safe system of work described in the method statement is understood. All persons involved in the lifting operation should be instructed to seek advice from the appointed person if any change is required to the lifting operation, or if any doubts about safety arise. If handlines/taglines are required to give more control of the load, the appointed person should designate persons to handle the lines.

k) Checking, if numerous loads are to be lifted over a long period, that no changes are required in the safe system of work.

l) Ensuring that there is a crane supervisor (see **7.2.2**) designated to direct personnel and that the operation is carried out in accordance with the method statement.

The appointed person and crane supervisor should be aware of the limits of their knowledge and experience concerning lifting operations, and when conditions exceed these limits, further advice should be sought.

4.3.3 Standard lift

If there are hazards, either within the working area of the crane or on the access route to the working area, the duties of the appointed person should include the following, in addition to the duties listed in **4.3.2**.

a) Investigating all hazards in the operating area, including any areas required for access or erection/dismantling of the crane.

NOTE Hazards can be from surrounding buildings, or overground or underground services.

b) Taking account of increased risks if the load is lifted from a structure at a height above the standing position of the crane.

NOTE Additional risks can arise from the crane driver not being able to observe the load while taking the initial strain, and movements due to deflections as the load is lifted clear of the supporting structure, making it not possible to put the load back down.

c) Liaison with any other person or authority, as required to overcome any hazard, by including any necessary corrective action or special measures in the safe system of work.

d) Consideration of the effect of the lifting operation on surrounding property or persons, including the general public. This should lead to arranging for appropriate action to minimize any adverse effects, and to giving appropriate notice to all persons concerned.

4.3.4 Complex lift

If the lifting operation is at a location with exceptional hazards (for example, at a chemical plant), persons are being lifted, lifting a load from height, or the load being lifted is a complex shape or with a large wind area then the appointed person should ensure, in addition to the duties listed in **4.3.2** and **4.3.3**, that:

a) the weight of the load and the position of its centre of gravity are accurately known;

b) the wind area of the load is known and a limiting wind speed for lifting is established;

c) any lifting points provided on the load are adequate for the loads applied;

d) the method statement includes access, ground conditions, erection etc., as well as the exact sequence of operations when lifting the load;

e) where persons are being lifted ensure that the requirements of Annex B are met.

Tower cranes should not be used for multiple lifts.

4.4 Duties of the persons involved in construction projects

The Construction (Design and Management) (CDM) Regulations [6] require that designers, planning supervisors, principal contractors, sub-contractors and clients consider health and safety matters throughout all stages of a construction project from conception, design and planning through to carrying out the work, including maintenance, repair and/or demolition.

Lifting operations are commonly carried out using cranes and they should be included in the Health and Safety Plan required by the CDM [6] so that factors influencing crane safety can be assessed at a sufficiently early stage.

When constructing the Plan, the ways in which the cranes are intended to be used, i.e. by the manufacturer and hirer, and any limitations that would affect safety in the conditions expected on site should be taken into account.

The Plan should include information to allow all parties involved in the specification, installation or use of cranes to be made aware of the fundamental criteria and planning issues needed to ensure that lifting operations are initiated and proceed in a logical and safe manner.

Designers should obtain and make available to the CDM planning supervisor, information relating to the site and type(s) of crane to be used.

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When designing a structure to be assembled by cranes designers should consult an appropriate appointed person at the design stage to ensure compatibility between structure components and the cranes that are likely to be lifting them into position. Further advice is given in CIRIA C654 [7] and the Construction Industry Council General Information Note I 002 [8].

NOTE Contractors have a duty to operate cranes safely, and this can be made extremely difficult by thoughtless design which puts pressure on them to use cranes at their operating limits and sometimes encourages improper use.

5 Contract lift or crane hire

5.1 General

Given the wide variety of contractual arrangements used in the construction industry, it is important to ensure that the planning, organization, control and management of lifting operations is not compromised. In general, any organization requiring a load to be moved by crane, which does not have its own craneage, has two basic options: hiring a crane (Hired Crane) or employing a contractor to carry out the lifting operation (Contract Lift). The difference between the two options is summarized in Figure 1.

If an individual or organization does not have expertise in lifting operations they should not hire cranes but should opt for a contract lift. Before entering into a contract, employing organizations should satisfy themselves that the contractor has the necessary competence to carry out the work.

NOTE Responsibilities for insurance in terms of the crane, personnel, the load and third parties might also need to be clarified.

5.2 Contract lifting operations

The employing organization may enter into a contract with a contractor who undertakes the work on their behalf.

The parties to the contract should ensure that:

a) all work is carried out in accordance with the BS 7121 series;

b) the contractor appoints a person, in accordance with **4.3** to the satisfaction of the employing organization;

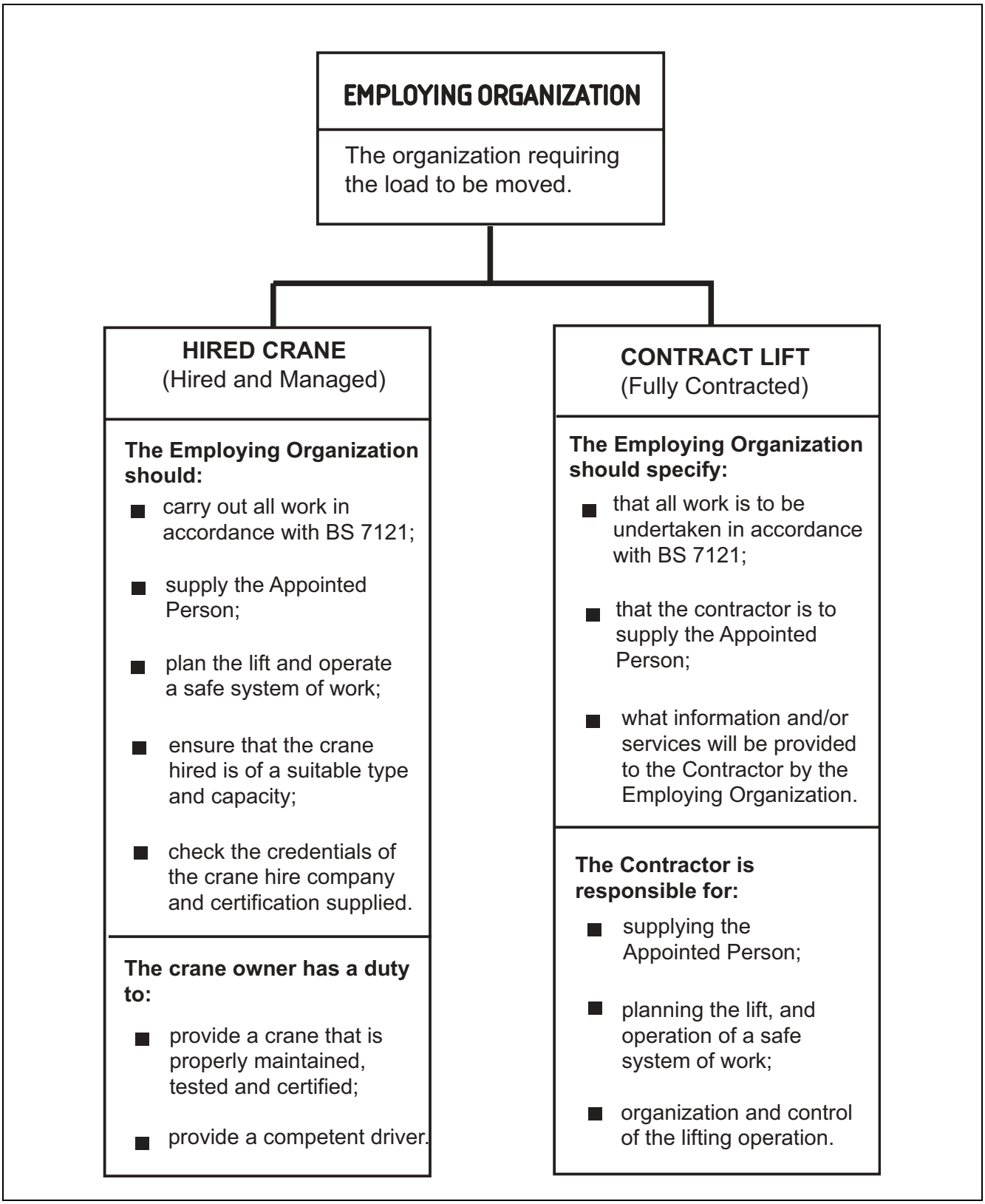
c) all information or services provided by the employing organization to facilitate compliance with the BS 7121 series are notified to the contractor in writing.

The contractor should carry out lifting operations in accordance with the BS 7121 series. The contractor should be given full authority by the employing organization to work in accordance with the BS 7121 series including, where appropriate, authority to control and instruct the employing organization's personnel.

NOTE Although the BS 7121 series is intended to assist organizations to comply with their statutory and common law obligations, it does not relieve them from these obligations.

Before entering into a contract, the employing organization should ensure that the contractor has the necessary competence to carry out the work in accordance with the BS 7121 series.

Figure 1 **Contract options**



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5.3 User's duties when using hired cranes

When a crane is hired out together with an operator to the user organization, the crane owner should provide a competent operator and a crane that is properly maintained, inspected and tested in accordance with BS 7121-2, and has a current report of thorough examination.

The user organization retains the responsibility for nominating the appointed person in accordance with **4.3** and for following the recommendations given in the BS 7121 series. Notwithstanding any advice the crane owner might have offered concerning the selection of a particular crane or any other relevant matter, for example clearances, ground conditions, the responsibility for ensuring that the crane is of a suitable type, size and capacity for the task being undertaken and for planning the operation remains with the user organization.

Therefore if an individual or organization does not have expertise in lifting operations, they should not hire cranes but should opt for a contract lift.

6 Planning of lifting operations when the crane is in use

6.1 General

All lifting operations should be planned to ensure that they are carried out safely and that all foreseeable risks have been taken into account. Planning should be carried out by an appointed person who has the appropriate knowledge for the lift being undertaken (see **4.3.2** and **4.3.3**).

In cases of repetitive or routine basic lifting operations, this planning might only be necessary in the first instance, with periodic reviews to ensure that no factors have changed.

For lifting operations carried out on construction projects, further information on the duties of personnel is given in **4.4**.

Planning of the lifting operation should take into account:

a) the load, its characteristics and the method of lifting;

   NOTE It may also be necessary to make allowance for any adhesion between the load and its support.

b) the selection of a suitable crane(s) appropriate to the operation ensuring that adequate clearances are maintained between the load(s) and the crane structure (see Clause **9**);

c) the selection of accessories for lifting/lifting attachments, the weight to be taken into account when assessing the load on the crane(s);

d) the position of the crane(s) and of the load before, during and after the operation (see **14.6**);

e) the site of the operation including proximity hazards, space availability and suitability of the ground or foundations;

f) any necessary erection and dismantling of the crane(s);

g) the environmental conditions that exist or could occur at the site of the operation, which could necessitate stopping the operation when conditions are unsuitable.

6.2 Risk assessment

6.2.1 The risk assessment carried out by the appointed person as part of the planning process should identify the hazards associated with the proposed lifting operation. The assessment should evaluate the risks involved and the nature and extent of any measures required to mitigate those risks. The appointed person should also take into consideration hazards identified by the overall site risk assessments.

NOTE Attention is drawn to the Management of Health and Safety at Work Regulations [9] which require that a risk assessment is carried out.

6.2.2 Generic risk assessments are unlikely to be sufficient since most sites have hazards that are unique to that situation and should be taken into account in the separate site specific assessment.

The results of the risk assessment should be recorded in writing and used in the preparation of the method statement (see **6.3**) for that site.

6.2.3 The risk assessment together with the manufacturer's instructions, should then be used to develop a detailed method statement for the safe transportation, assembly, erection, use and dismantling of the equipment at that site.

6.3 Method statements

6.3.1 Once the risk assessment has been carried out, the appointed person (see **4.3**) should ensure that a full method statement is prepared, detailing the safe system of work (see **4.1**) for the lifting operation and including the risk assessment.

6.3.2 The appointed person should, when necessary, consult with others with specialized knowledge and experience to assist in the planning process for which the appointed person retains responsibility.

6.3.3 The method statement should include:

a) the tasks to be achieved and the sequence in which they are to be carried out;

b) the configuration of the crane when not in use;

c) details of the steps to be taken to eliminate danger to personnel not involved in the lifting operation, and where necessary, prevent their entry into danger zones, e.g. by organizing for road closures if necessary;

NOTE Exclusion zones generally require the agreement of the principal contractor.

d) the requirement for pre-use checks to be completed;

e) a clear statement of the allocation of tasks to all parties involved in the lifting operation.

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6.3.4 The lifting operation will be under the control of a crane supervisor who has the authority to stop the work if local conditions are unsatisfactory.

6.3.5 The crane supervisor should ensure that all persons involved in the lifting operation (the lifting team) are inducted in the general site precautions and the specific features of the method statement at the start of the job.

6.3.6 A copy of the method statement and associated operating instructions should be given to all those involved in the planning of the lifting operation.

6.3.7 The method statement should be sufficient to provide the basis for a briefing or induction of each member of the team (see **12.1.7.6**).

The crane supervisor or principal contractor's representative should normally take the opportunity during the site induction to seek the views of the team about any arrangements for health and safety that might be relevant to them.

6.3.8 To be effective the method statement needs to specify clear roles for each member of the team. Arrangements for effective communication among the team (and if necessary with adjacent crane operators in case of danger) should be available.

NOTE The appointed person may delegate the task of preparing the method statement to another person; however they retain responsibility for the method statement. It is essential that the appointed person sign and date the document before it is issued for use to signify their approval of the method statement's content.

7 Selection and duties of personnel

*NOTE See **4.3** for the selection and duties of the appointed person.*

7.1 Selection of personnel

Safe lifting operations (including installation) depend upon the selection of suitable personnel who are competent to carry out the required duties. Records of training and experience of persons such as the crane operator assist in the selection of suitable personnel. Crane operators and slingers should be trained in accordance with the recommendations given in Annex C.

Those responsible for the selection of personnel should ensure that the personnel involved in the operation are efficiently organized in order to ensure good team-work in the working situation.

Work associated with lifting operations should not be carried out by personnel whose efficiency is impaired by alcohol, drugs or other influences. It is essential that all personnel in the team are made aware of both this fact and their other duties (see **7.2**).

Where personnel are under training, they should be supervised by appropriate personnel.

*NOTE For basic lifts it may be appropriate for one person to undertake more than one of the duties identified in **7.2**, depending on the hazards identified by the risk assessment.*

7.2 Duties of personnel

7.2.1 Crane supervisor

NOTE The appointed person may decide to undertake the duties of the crane supervisor or to delegate these to another person with appropriate expertise for the lifting operation.

The crane supervisor should direct and supervise the lifting operation, ensuring that these are carried out in accordance with the method statement. The crane supervisor should be competent and suitably trained and should have sufficient experience to carry out all relevant duties. The crane supervisor should have sufficient authority to stop the lifting operation if they consider it dangerous to proceed.

7.2.2 Crane coordinator

The crane coordinator should plan and direct the sequence of operations of tower cranes to ensure that they do not collide with other cranes, loads and other equipment (e.g. concrete placing booms, telehandlers, piling rigs).

7.2.3 Crane operator

The crane operator should be responsible for the correct operation of the crane in accordance with the manufacturer's instructions and within the safe system of work (see **4.1**).

The crane operator should at any one time only respond to the signals from one slinger/signaller who should be clearly identified (see **10.2**).

In an emergency a commonly recognized stop signal may be given by any person observing a situation leading to danger and the crane operator should respond to that signal.

7.2.4 Slinger

The slinger should be responsible for attaching and detaching the load to and from the crane hook and for the use of the correct accessories for lifting and other equipment in accordance with the planning of the operation.

The slinger is responsible for initiating and directing the safe movement of the crane [see **8.5**h)].

If there is more than one slinger, one should be designated as the "slinger in charge" by the crane supervisor.

Where continuity of signalling is required and this slinger is not visible to the crane operator, another slinger or signaller may be necessary to relay signals to the crane operator. Alternatively, other audio or visual methods may be used.

Where audio or visual methods are used, the equipment or its means of use should be such that the operator is immediately aware of failure of the equipment, to enable them to stop crane movements.

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Typical examples of audio or visual methods used are as follows.

a) A blank screen on a television monitor immediately indicates that the operator should stop all crane movements.

b) A slinger using a radio should continuously instruct the operator to lower a load, e.g. by saying "Lower-lower-lower...", and failure of this continuous instruction from the slinger indicates that the operator should halt all crane movements.

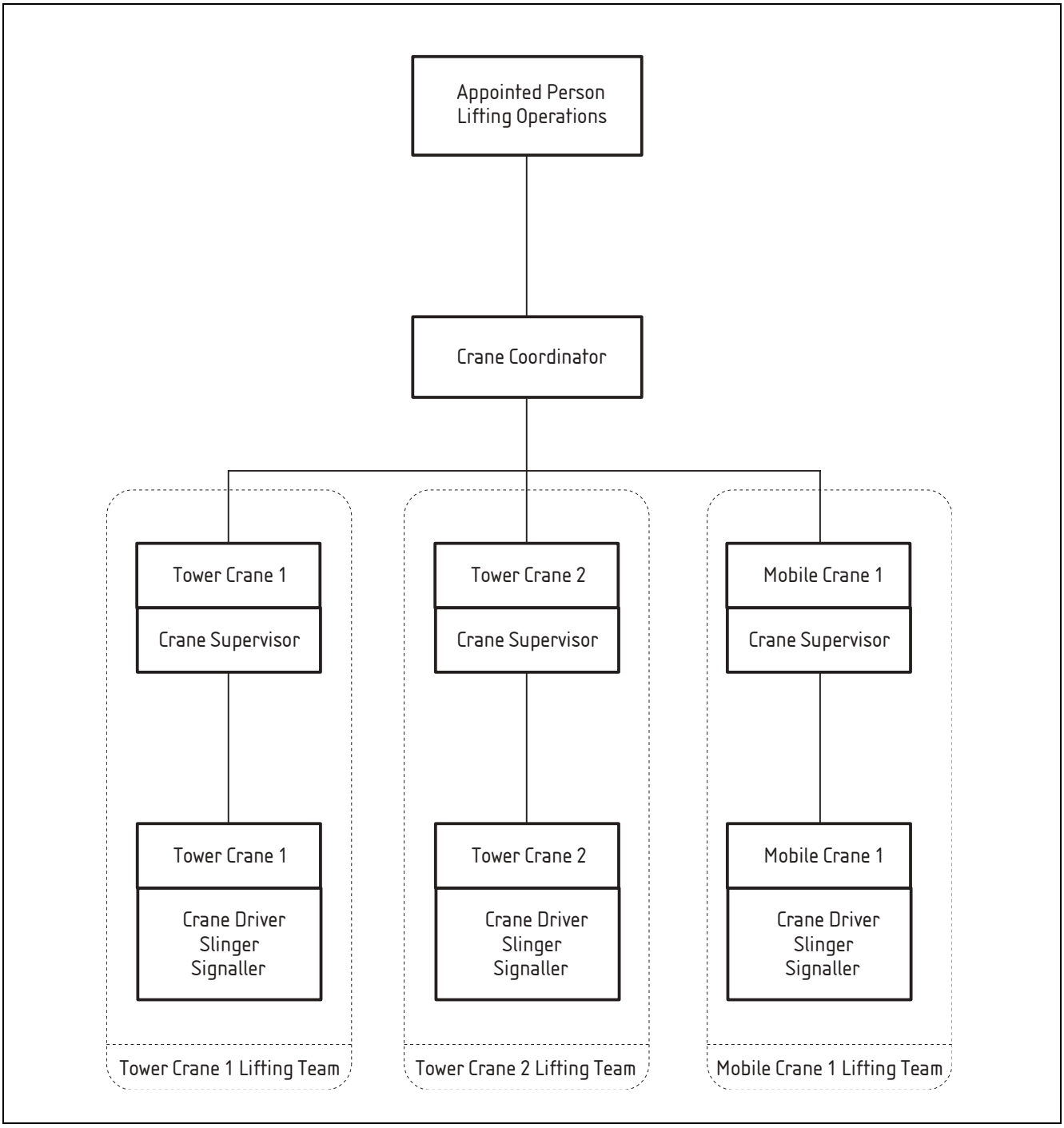
If, during the lifting operation, responsibility for directing the crane and load is to be transferred to another nominated person, the slinger should clearly indicate to the crane operator that this responsibility is being transferred and to whom, and the slinger should clearly indicate to the new nominated person that this transfer is taking place. Furthermore, the operator and the new nominated person should clearly indicate that they accept the transfer of responsibility.

7.2.5 Signaller

NOTE Figure 2 shows the flow of information and control of lifting operations between personnel.

The signaller should be responsible for relaying the signal from the slinger to the crane operator. The signaller may be given the responsibility for directing movement of the crane and load instead of the slinger, provided that only one person has the responsibility.

Figure 2 **Flow of information between personnel involved in lifting operations**



7.2.6 Maintenance personnel

The maintenance personnel should be responsible for maintaining the crane and ensuring its safe and satisfactory operation. They should carry out all necessary maintenance in accordance with the manufacturer's maintenance manual and within the safe system of work (see **4.1**).

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7.2.7 Erector

The erector should be responsible for working on the installation of the crane in accordance with the manufacturer's instructions and a job specific method statement, working under the guidance of a senior erector or erection supervisor.

7.2.8 Senior erector

The senior erector should have the responsibilities of an erector in addition to the following.

a) Supervision of erectors as directed by the erection supervisor.

b) Responsibility for, and close monitoring of, any trainee erectors involved with the installation of the crane.

7.2.9 Crane erection supervisor

The crane erection supervisor should have the responsibilities of a crane erector in addition to the following.

a) The crane erection supervisor should be in control of all senior erectors, erectors and trainee erectors and of any additional craneage and lifting equipment which could be used in the erection/dismantling operation, thereby fulfilling the role of the crane supervisor.

b) The crane erection supervisor should provide a means for ensuring that the operation is carried out in accordance with the method statement.

c) Additional craneage and equipment should be in accordance with that specified and properly certified.

d) All erectors should be equipped with the necessary tools and personal protective equipment.

*NOTE The appointed person (see **4.3**) retains overall responsibility for the erection/dismantling operation, including the planning.*

If the crane erection supervisor has to leave the site of the operation, even for a few minutes, he or she should appoint another member of his/her team to be in charge during the period of absence, in order to prevent any ambiguity as to the control of the operation.

The crane erection supervisor should attempt to remain on site throughout the whole of the erection/dismantling operation.

7.2.10 Trainee erector

The trainee erector should be responsible for working on the installation of the crane under the direct supervision of a senior erector.

8 Minimum attributes of personnel

NOTE 1 This clause also includes information on training of personnel.

*NOTE 2 See **4.3** for the duties of the appointed person in lifting operations.*

8.1 General

All personnel should be:

a) competent;

b) adequately trained and assessed;

c) able to present a record of training and assessment;

d) physically able to carry out the work;

e) assessed for their ability to work confidently and safely at height;

f) assessed for health in accordance with the recommendations of HS(G)6 [10].

8.2 Crane supervisor

The crane supervisor should be:

a) authorized to carry out the duties listed in **7.2.1**;

b) fully conversant with the duties of all persons involved in the lifting operation;

c) able to give clear, unambiguous instructions to all other members of the team;

d) able to assess danger to the lifting operation from changed circumstances on site, and to call a halt to the operation if the risk becomes unacceptable, so that the appointed person can be referred to for further instructions.

If the crane supervisor is also a crane operator, then the crane supervisor should not operate any crane involved in the lifting operation being supervised.

8.3 Crane coordinator

The crane coordinator should be:

a) over 18 years of age;

b) fit, with particular regard to eyesight, hearing, reflexes and agility;

c) capable of giving precise and clear verbal instructions where audio equipment (e.g. radio) is employed, and capable of operating such equipment in accordance with **16.2**;

d) familiar with the types of crane and lifting equipment to be used on site in terms of capacities, size, speed of operation, method of control, limitations, etc.

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8.4 Crane operator

The crane operator should be:

a) either over 18 years of age or under the direct supervision of a person competent for the purpose of training;

b) fit, with particular regard to eyesight, hearing and reflexes;

c) physically able to operate the crane safely;

d) able to judge distances, heights and clearances;

e) adequately trained for the type of crane being driven and have sufficient knowledge of the crane, its operating instructions and its safety devices (see Annex C);

f) fully conversant with the duties of the slinger and signaller, and have been instructed in the signal code shown in Figure 3 and any alternative methods of relaying the signals that are to be used, in order to implement safely the instruction of the slinger or signaller;

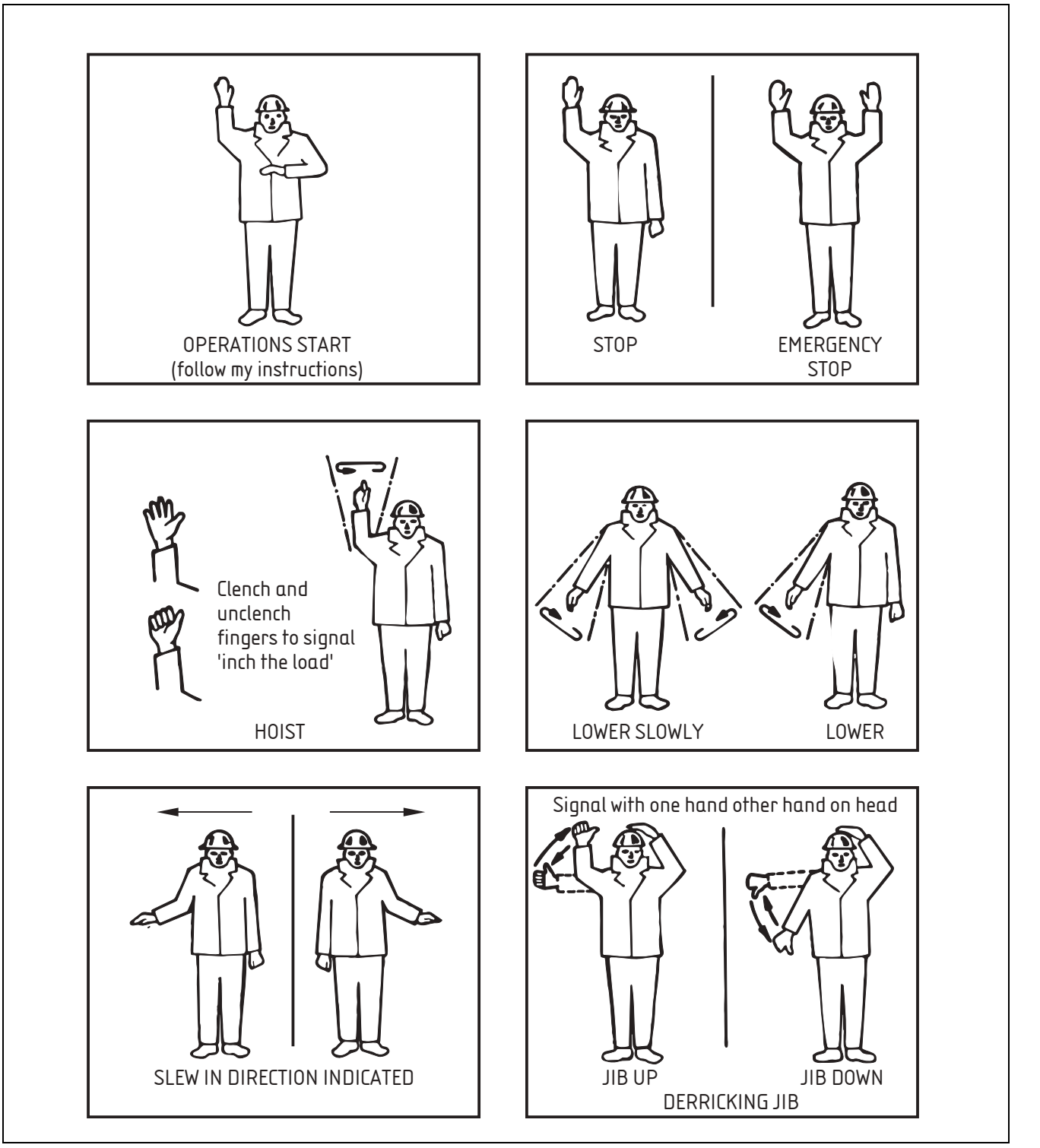
g) trained in the use of the fire extinguishing/fighting equipment on the crane (where provided);

h) trained in the use of any means provided for escape in case of emergency;

i) authorized to operate the crane.

Evidence that the operator is medically fit to drive a crane should be obtained at not more than 5 yearly intervals. The type of evidence obtained is dependent on the type of crane being operated and the risks to the operator and others involved in the operation.

Figure 3 **Hand signals**



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8.5 Slinger

The slinger should be:

a) either over 18 years of age or under the direct supervision of a person competent for the purpose of training;

b) fit, with particular regard to eyesight, hearing, reflexes and agility;

c) physically able to handle accessories for lifting and equipment;

d) able to establish weights, balance loads and judge distances, heights and clearances;

e) trained in the techniques of slinging;

f) capable of selecting accessories for lifting and equipment in suitable condition for the load to be lifted (see BS 6166-3 and BS 6210);

g) trained in the techniques of signalling and have been instructed in the signal code shown in Figure 3;

h) capable of giving precise and clear verbal instructions where audio equipment (e.g. radio) is used and capable of operating the equipment in accordance with **16.2**;

i) capable of initiating and directing the safe movement of the crane and load;

j) authorized to carry out slinging duties.

8.6 Signaller

The signaller should be:

a) either over 18 years of age or under the direct supervision of a person competent for the purpose of training;

b) fit, with particular regard to eyesight, hearing, reflexes and mobility;

c) able to judge distances, heights and clearances;

d) trained in the techniques of signalling and have been instructed in the signal code shown in Figure 3;

e) capable of giving precise and clear verbal instructions where audio equipment (e.g. radio) is employed and capable of operating the equipment in accordance with **16.2**;

f) capable of directing the safe movement of the crane and load;

g) authorized to carry out signalling duties;

h) aware of the responsibilities allocated by the appointed person (see **7.2.3** and **7.2.4**) to the crane operator and slinger.

8.7 Maintenance personnel

Maintenance personnel should be:

a) fully conversant with the machinery they are required to maintain and its hazards;

b) properly instructed and trained. Where special machinery is involved this should include attending appropriate courses given by the supplier of the equipment;

c) familiar with the procedures and precautions recommended in Clause **14**;

d) fully conversant with the appropriate sections of the manufacturer's instruction manual;

e) familiar with the use of permit to work systems where they are required by the safe system of work, and able to operate them correctly;

f) familiar with all aspects of their personal protective equipment and capable of using it correctly.

8.8 Crane erector

The crane erector should be:

a) either over 18 years of age or under the direct supervision of a person competent for the purpose of training;

b) fit, with particular regard to eyesight, hearing, reflexes and agility;

c) physically able to handle safely the loads involved in crane erection;

d) able to work confidently and safely at heights;

e) able to establish weights, balance loads and judge distances, heights and clearances;

f) trained in the techniques of slinging and signalling;

g) capable of selecting lifting gear and equipment that is suitable for the load to be lifted;

h) adequately trained in the erection, dismantling and working of the type of crane being erected, and in the safe use and setting up of any lifting appliance used in the course of these duties;

i) capable of assessing that components and equipment are in a suitable condition for incorporation into the crane being assembled;

j) adequately trained in the setting and testing of the safety devices fitted to the crane being erected.

8.9 Senior erector

The senior erector should have the same attributes as the crane erector and:

a) have at least three years' experience in the erection and dismantling of tower cranes or similar equipment;

b) be conversant with the manufacturer's instruction manual for the particular crane;

c) be trained in the control of personnel carrying out the duties of erecting and dismantling tower cranes, and in ensuring that all persons use their personal protective equipment correctly;

d) be trained in the direct supervision and monitoring of trainees gaining experience in the erection and dismantling of tower cranes.

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8.10 Erection supervisor

The crane erection supervisor should have the same attributes as the crane erector and:

a) have at least five years' experience in the erection and dismantling of tower cranes or similar equipment, and be trained in the supervision of such operations;

b) be fully conversant with the manufacturer's instruction manual for the particular crane;

c) be trained in the control of personnel carrying out the duties of erecting and dismantling tower cranes, and in ensuring that all persons use their personal protective equipment correctly;

d) be able to demonstrate knowledge of the certification requirements for all equipment used.

The crane erection supervisor should be in possession of the manufacturer's instruction manual for the particular crane.

8.11 Trainee erector

The crane erector should be:

a) over 18 years of age unless under the direct supervision of a person competent for the purpose of training;

b) fit, with particular regard to eyesight, hearing, reflexes and agility;

c) physically able to handle safely the loads involved in crane erection;

d) able to work confidently and safely at heights;

e) able to establish weights, balance loads and judge distances, heights and clearances;

f) trained in the techniques of slinging;

g) capable of selecting lifting gear and equipment that is suitable for the load to be lifted.

8.12 Training of erection personnel

8.12.1 Basic skills

All tower crane erection personnel should be trained in a set of basic skills to enable them to work safely on site and participate effectively in the climbing process. These basic skills should include the following.

a) Understanding basic site safety.

b) Slinging and signalling.

c) Basic tool skills which includes the selection and use of tools.

d) Identification, selection and fitting of fasteners.

e) Use and maintenance of fall protection equipment (working at height).

NOTE Further information on selection, use and maintenance of personal fall protection systems and equipment is given in BS 8437.

f) Interpretation of technical information, use of manuals.

g) Basic assessment of ground conditions.

h) Basic assessment of weather conditions.

i) Basic principles of tower crane erection and stability, including verticality checks.

j) Basic practice of erection and dismantle.

k) Product familiarity which is limited to cranes on which initial training is being carried out.

l) Preparing equipment for use.

m) Effective communication including the use and care of radio equipment.

n) Assisting with examinations and testing.

o) Identifying proximity hazards.

NOTE A suitable programme for the training of tower crane installation personnel is the Tower Crane Installation Training Programme, TWR 01 [11] developed jointly by the Construction Plant–hire Association, the Construction Industry Training Board and the HSE.

8.12.2 Additional skills

As tower cane erectors gain experience, their basic set of skills should be augmented with additional skills, including the following.

a) Product familiarity (to be added as part of erectors' ongoing training).

b) First aid.

c) Wire rope inspection and termination.

d) Use of specialist tools and equipment.

e) Foundation checking.

f) Tying to structures.

g) Climbing (internal and external).

h) Setting limits, including RCI/L.

i) Functional testing.

j) Carrying out thorough examinations and testing.

k) Carrying out maintenance.

l) Carrying out adjustments (complex and not).

m) Identifying and rectifying faults in equipment.

n) Operating the crane during erection/dismantle.

o) Operating the crane whilst the crane is working.

p) Commissioning and handover to operator.

q) Training to become a Lift Supervisor.

r) Training to become an Appointed Person.

s) Loading components onto transport.

t) Supervision skills.

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8.12.3 Familiarization with new systems or equipment

All tower crane erection personnel need additional training from time to time before they work on new systems or equipment with which they are not familiar. The nature and extent of this training depends on the complexity of the new equipment and the degree of difference from the equipment with which they are familiar.

8.12.4 Assessment

It is important that all personnel in the erection team are regularly assessed to ensure that they can carry out their duties safely and effectively. Assessment should form part of any training.

NOTE Training assessment tools are given in the Tower Crane Installation Training Programme, TWR 01 [11].

8.12.5 Traceability of training to manufacturers

The training of erection personnel does not necessarily need to be carried out by the equipment manufacturer. However the training should be directly traceable to the manufacturer with the person delivering the training having been appropriately trained by the manufacturer.

8.12.6 Health and fitness

Tower crane installation operations involve a substantial degree of physical work and those engaged in it should possess a level of physical strength and fitness that enables them to carry out their duties effectively and without endangering the other members of the erection team. Personnel should be advised that they may not be a member of the team if their efficiency is impaired by alcohol, drugs or other influences.

Evidence that members of the erection team are medically fit to carry out their duties should be obtained at not more that five yearly intervals. Advice on health assessment is given in HS(G)6 [10].

9 Selection of tower cranes

9.1 General

Tower cranes are available in a number of forms and the characteristics of the various machines should be considered in relation to the job requirements. Having decided upon the type of crane and knowing the overall requirements involved, a crane that can carry out the planned lift safely should be selected.

Points to be taken into account in making the selection of the tower crane include the following:

a) weights, dimensions and characteristics of loads;

b) operational speeds, radii, heights of lifts and areas of movement;

c) number, frequency and types of lifting operations;

d) length of time for which the crane is required or anticipated life expectancy for a permanently installed crane;

e) remaining life expectancy;

f) site, ground and environmental conditions, or restrictions arising from the use of existing buildings;

g) space available for crane access, erection, travelling, operation, out-of-service condition and dismantling;

h) any special operational requirements or limitations imposed;

i) prevailing wind-speeds, which can restrict the use of tower cranes in certain locations;

j) principal features of the common types of tower crane, as described in this code of practice;

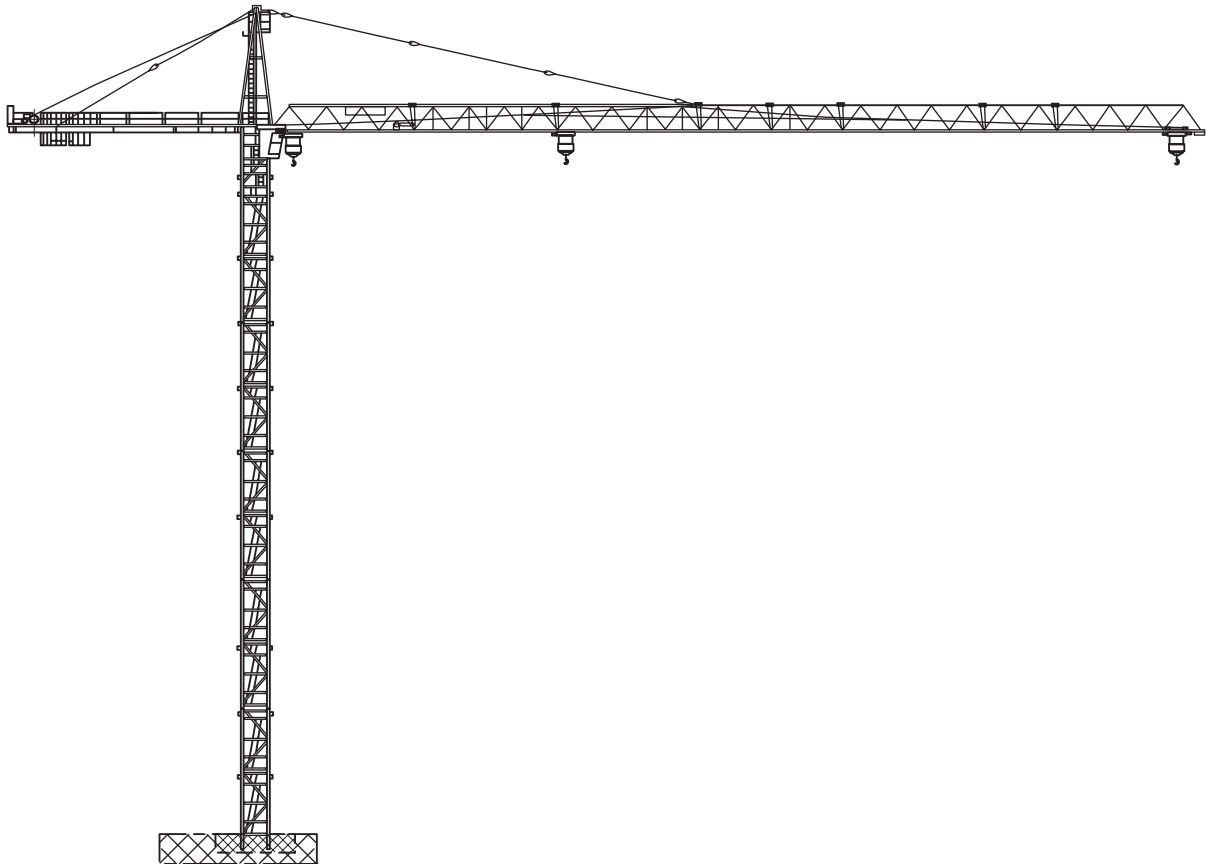
k) clearances around the base of bottom slew self-erecting tower cranes.

NOTE Static and mobile tower cranes are available in a wide variety of types and configurations according to the particular combination of tower, jib and type of base which they employ. Individual cranes can comprise almost any combination of the features shown in Figure 4, Figure 5 and Figure 6.

9.2 Types of tower

NOTE Types of crane are illustrated in Figure 4.

Figure 4 **Types of tower**



a) Fixed tower (top slew)

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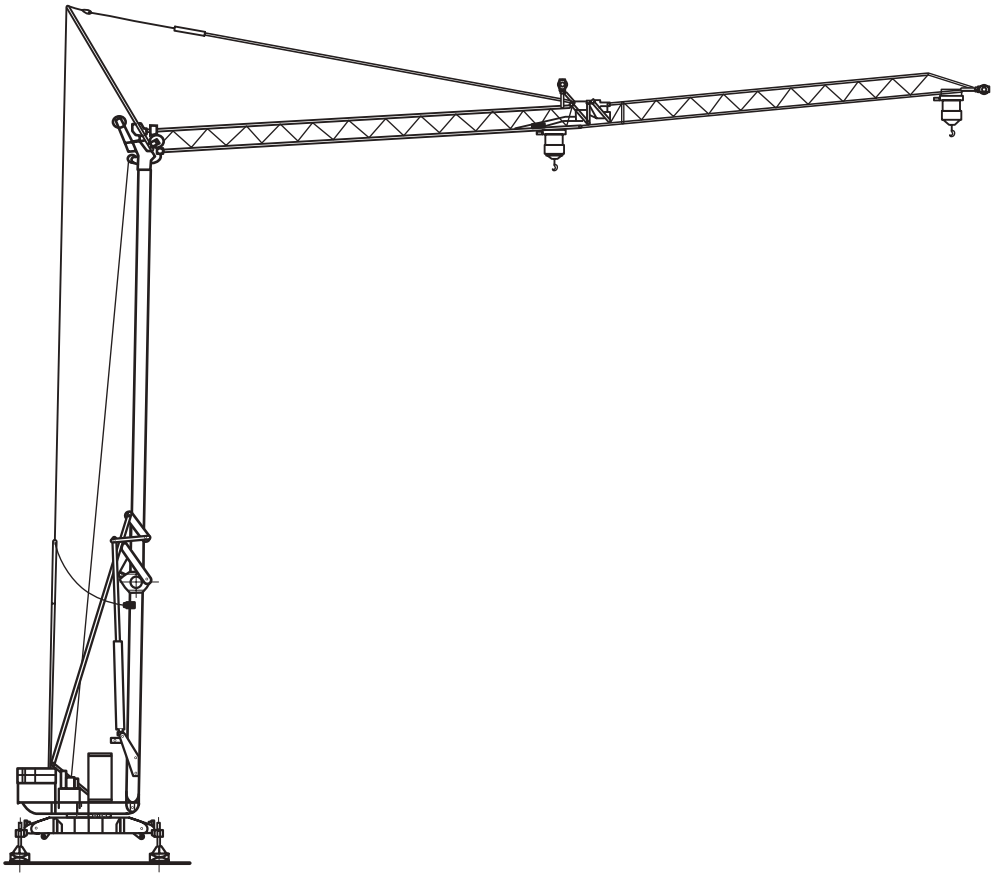
Figure 4 **Types of tower** *(continued)*



b) Slewing tower (self erecting)

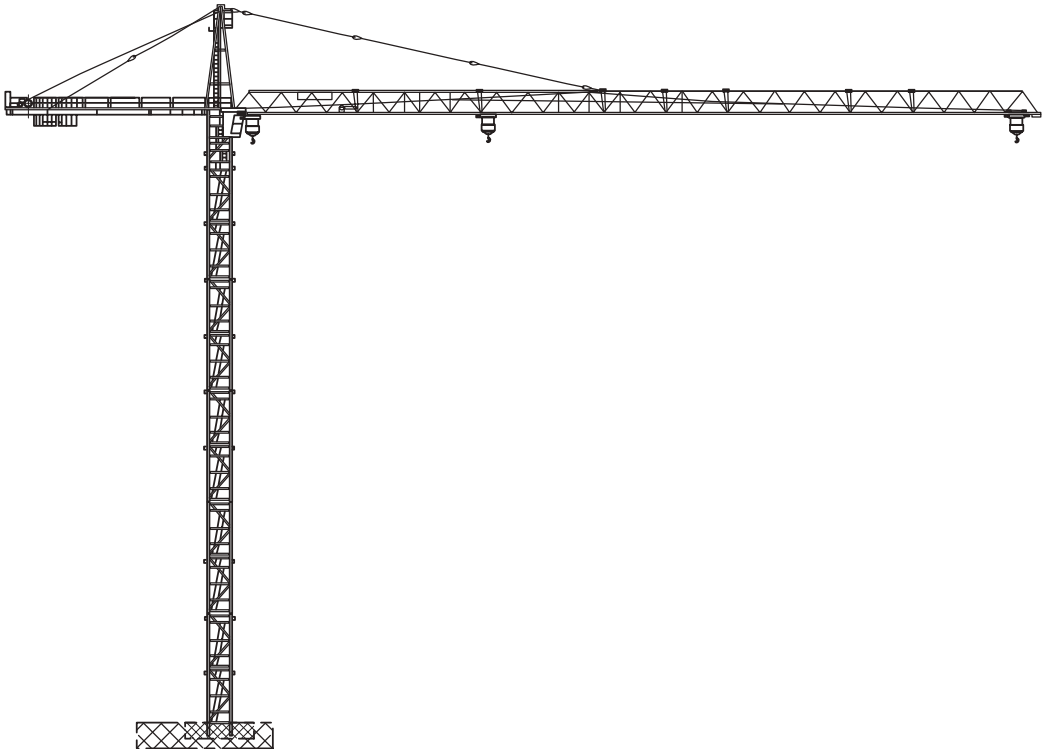
Tower cranes have either a non-slewing or slewing tower. With a non-slewing tower, the slewing ring is situated at or near the top of the tower and the jib slews about the vertical axis of the tower, which itself remains stationary. With a slewing tower, the slewing ring is situated at the bottom of the tower and the whole of the tower and jib assembly slews relative to the base of the crane.

Where non-slewing towers have to be tied to a fixed structure, it is imperative that the manufacturer's instructions are followed. The ties should be designed by a competent person to withstand the loads specified by the manufacturer, and be attached to a structure capable of withstanding the imposed loads.

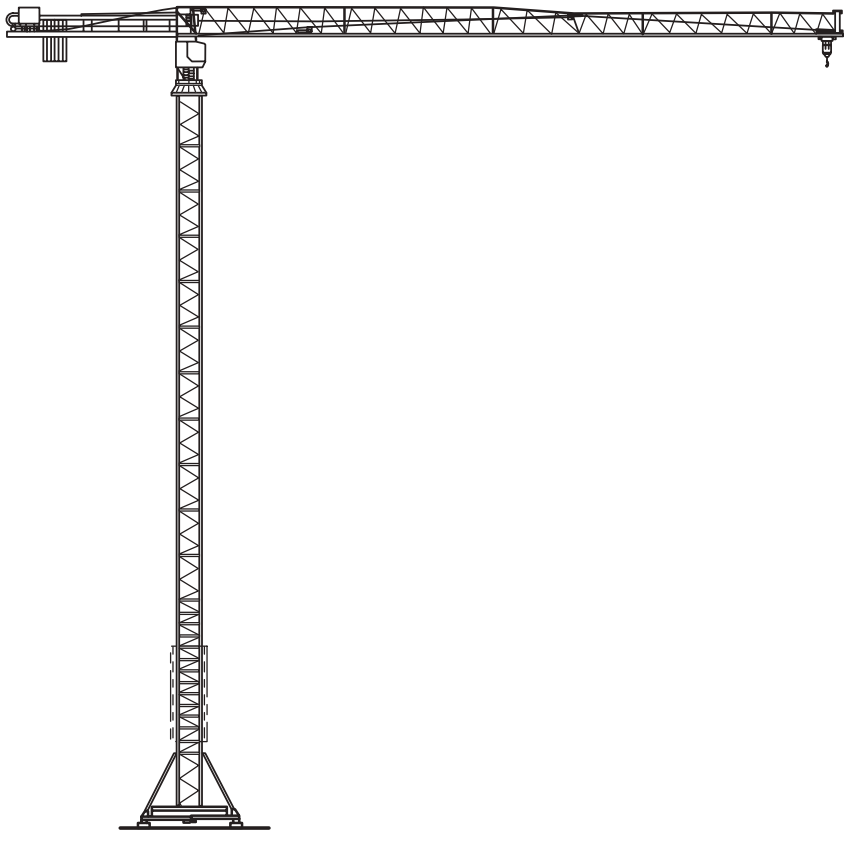
9.3 Types of jib

NOTE Types of jib are illustrated in Figure 5.

Figure 5 **Types of jib**



a) A frame jib



b) Flat top jib

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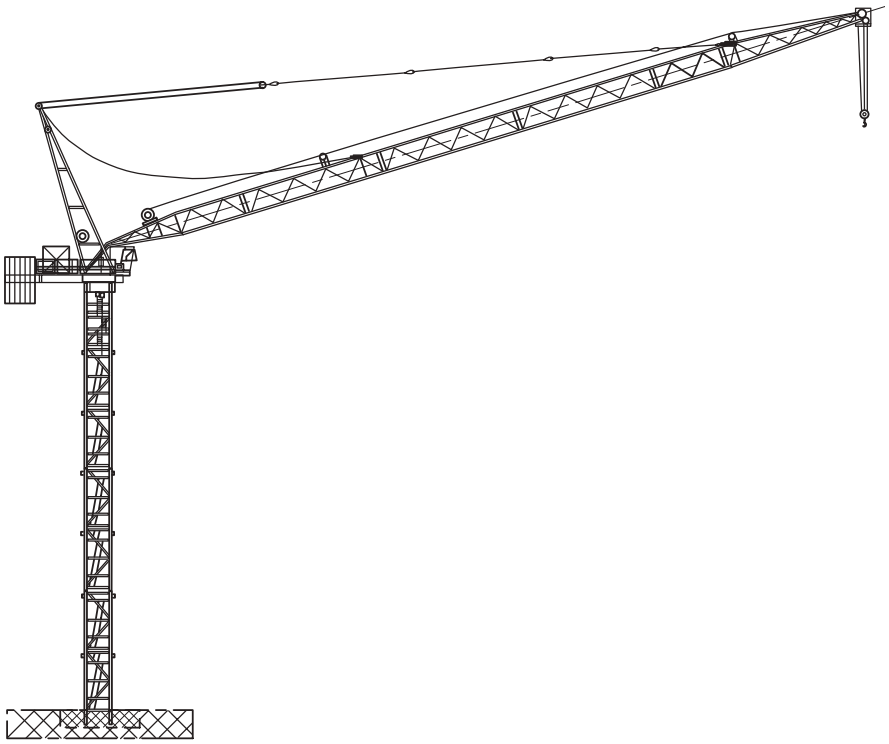
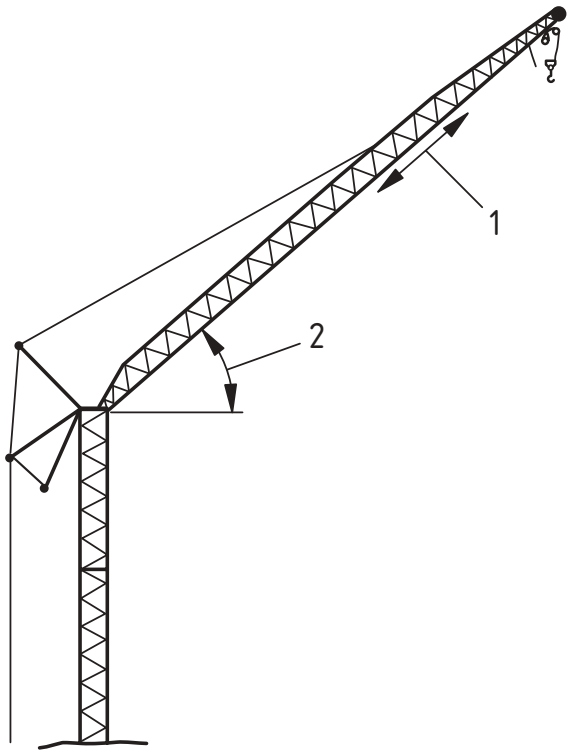
Figure 5 **Types of jib** *(continued)*



c) Luffing jib



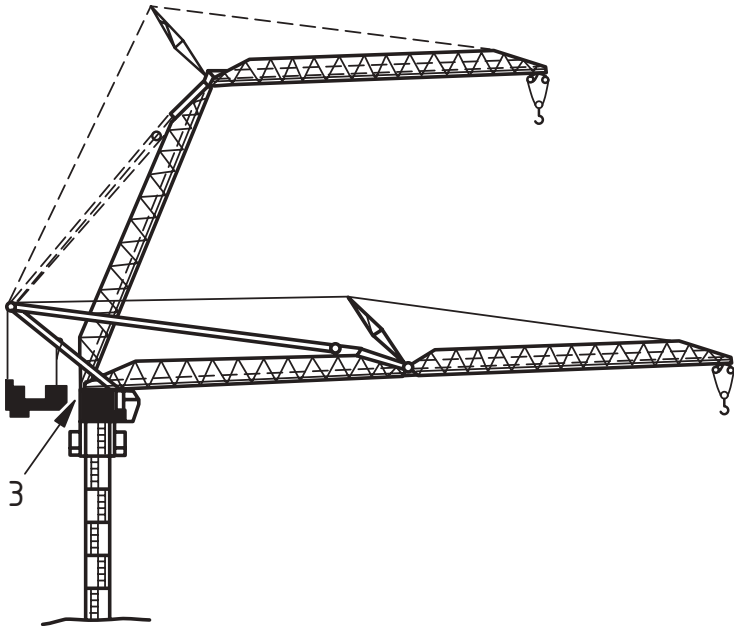
Key

1 Trolley moves along boom to alter load radius

2 Jib does not change

d) Fixed jib

Figure 5 **Types of jib** *(continued)*



Key
3 Pivot

e) Rear pivoted jib

9.3.1 Horizontal trolley jib (A frame type)

An A frame type horizontal trolley jib is held in a horizontal or slightly raised position by tie bars or ropes connected to an "A" frame on the top of the crane tower. The hook is suspended from a trolley which moves along the jib to alter the hook radius. A suitable allowance needs to be made for deflection when calculating the clearance between adjacent cranes (see **4.2.2**).

9.3.2 Horizontal trolley jib (Flat top type)

A flat top type horizontal trolley jib is connected directly to the tower top and does not require tie bars or ropes connected to an "A" frame. This reduces the overall height of the crane which can be important on congested sites and where adjacent cranes oversail. The hook is suspended from a trolley which moves along the jib to alter the hook radius. A suitable allowance needs to be made for deflection when calculating the clearance between adjacent cranes (see **4.2.2**).

9.3.3 Luffing jib

The jib angle of a luffing jib can be changed to reposition the load at various radii. The jib could be single- or multi-component, and if multi-component, could be articulated (goose necked) or telescopic. Due to the varying out-of-service conditions for these cranes particular care should be taken to observe the manufacturer's instructions [see **14.6**b)].

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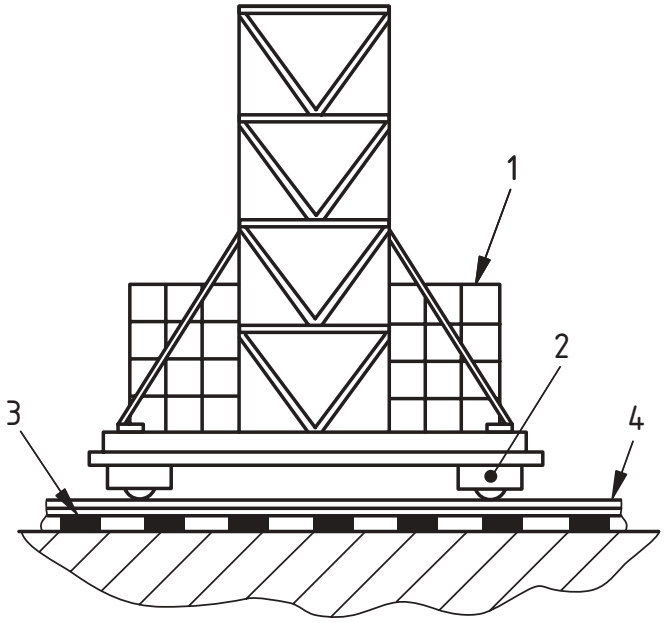
9.3.4 Fixed radius jib

The radius at which the load is carried cannot be varied. Fixed radius jibs are usually only available on small tower cranes (self-erectors and similar), and it is generally desirable to be able to travel the crane in order to move the load.

9.4 Types of base

NOTE Types of base are illustrated in Figure 6.

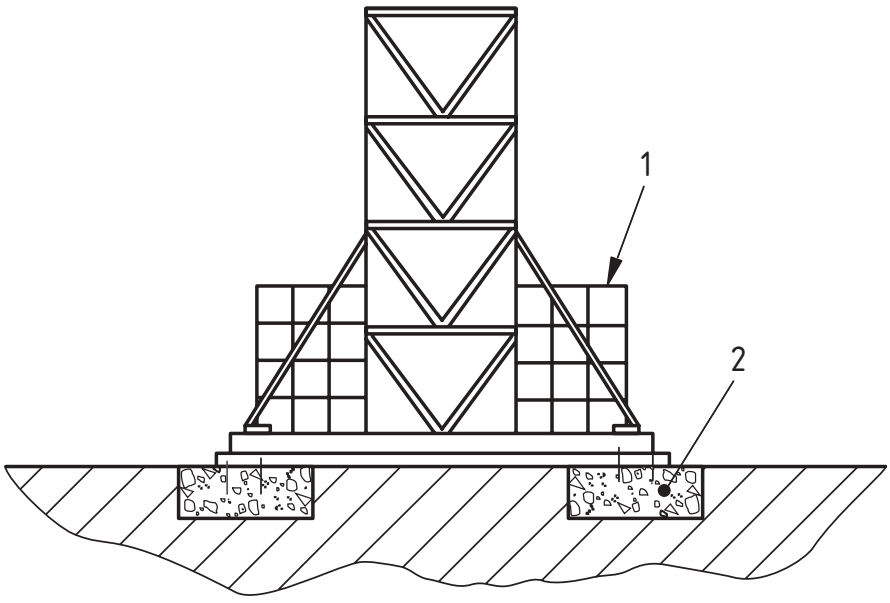
Figure 6 **Types of base**



Key

1 Base ballast
2 Bogies
3 Sleepers
4 Rail

a) Travelling base (rail type)

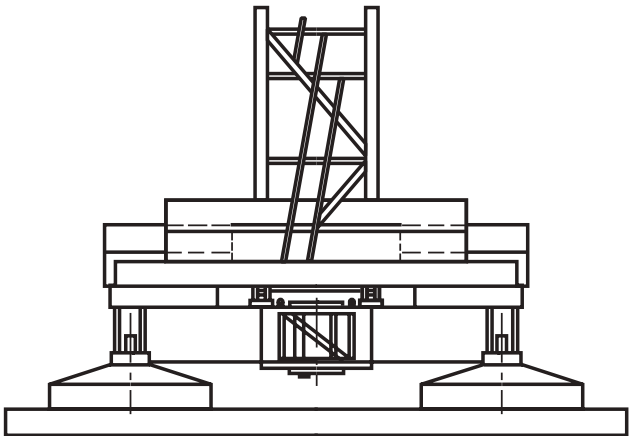


Key

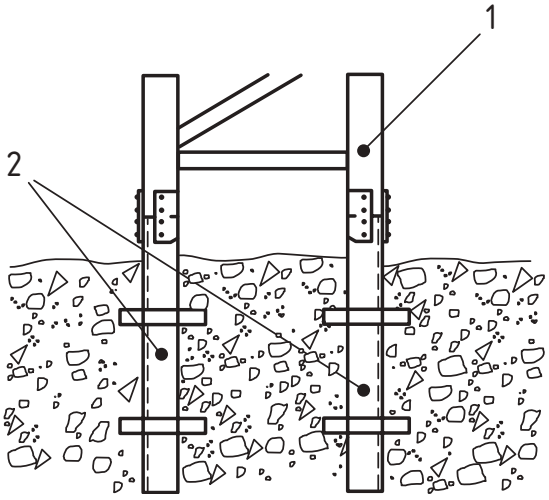
1 Base ballast
2 Means to prevent movement

b) Travelling base (static)

Figure 6 **Types of base** *(continued)*



c) Cruciform base



Key

1 Base of crane tower

2 Fixed angle

d) Expendable base

9.4.1 Cast-in base

NOTE It is important that the foundation anchors or expendable tower section are installed within the maker's tolerance of accuracy to ensure that the erected crane is within operational limits.

A crane with a cast-in base is mounted on special foundation anchors or an expendable tower section which are cast into a concrete foundation block. See Figure 4d). This block should have sufficient weight and base area to resist the moments and forces imposed by the crane. The design of these foundations should be carried out by a competent engineer.

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9.4.2 Cruciform base

A crane with a cruciform base stands on its own base of steel sections in the form of a cross. Overturning moments are resisted by either placing ballast on the top of the base or fastening the corners of the cruciform to the supporting structure. The design of the supporting structure and any connections to the cruciform base should be carried out by a competent engineer.

Where ballast blocks are used there should be a notice attached detailing the position and weight of the blocks, and that the blocks should be adequately secured to prevent accidental displacement. The ballast arrangement should not be altered after the crane has been tested, for constructional or any other reasons.

Cruciform bases cover a larger area than cast-in bases and therefore might not be suitable for congested sites.

9.4.3 Travelling base

A crane with a travelling base has a tower mounted on a steel structure, similar to a cruciform base, which is supported on bogies that run on rail tracks (see **9.5.2**). The travelling base is ballasted to ensure stability and may also be used, in accordance with the manufacturer's instructions, statically in a similar manner to a cruciform base.

9.4.4 Grillage base

A grillage base is a steel structure to which the tower of the crane is connected and which in turn is connected to the supporting structure. Grillages are generally designed specifically for each location. The design of grillages and their connections to the supporting structure should be carried out by a competent engineer.

9.4.5 Non-crane structure

NOTE Further information on ground assessment and the design of crane foundations is given in CIRIA C703 [12].

A non-crane base structure is a base provided by a structure which is not a normal part of the crane, for example part of a bridge, a building or structure provided specifically for such a purpose. The design of a non-crane base structure should be carried out by a competent engineer.

9.5 Types of tower crane

9.5.1 Climbing crane

A climbing crane is a tower crane that can be altered in height after initial erection. Where the crane remains on its original base this can be achieved by the use of internal telescoping equipment or external climbing frames. Another type of climbing crane can ascend through a structure using a climbing frame, the supported crane being provided by the surrounding structure. See **13.2**.

This type of crane requires less initial outlay due to the reduced quantity of mast required, but it has disadvantages in that the structure needs to have adequate strength and rigidity to carry the imposed loads, and the mast through the middle of the structure can interfere with the completion of the structure. Dismantling of the crane once the structure is completed should also be taken into account when selecting tower cranes.

9.5.2 Rail mounted tower crane

*NOTE Rail tracks for tower cranes are described in **11.5.2**.*

A rail mounted tower crane is mounted on a chassis frame which is supported on rail wheels which are usually double flanged. There can be four single wheels on smaller machines or more usually four double wheel bogeys. The wheels or bogeys can have special mountings to enable the crane to negotiate bends. Rail mounted tower cranes may be of any of the types described in **9.2** and **9.3**. Stability is normally obtained by means of ballast weights which should be adequately secured to prevent accidental displacement or removal, and the detail of the ballast should be on the notice near the base of the crane giving the crane capacities.

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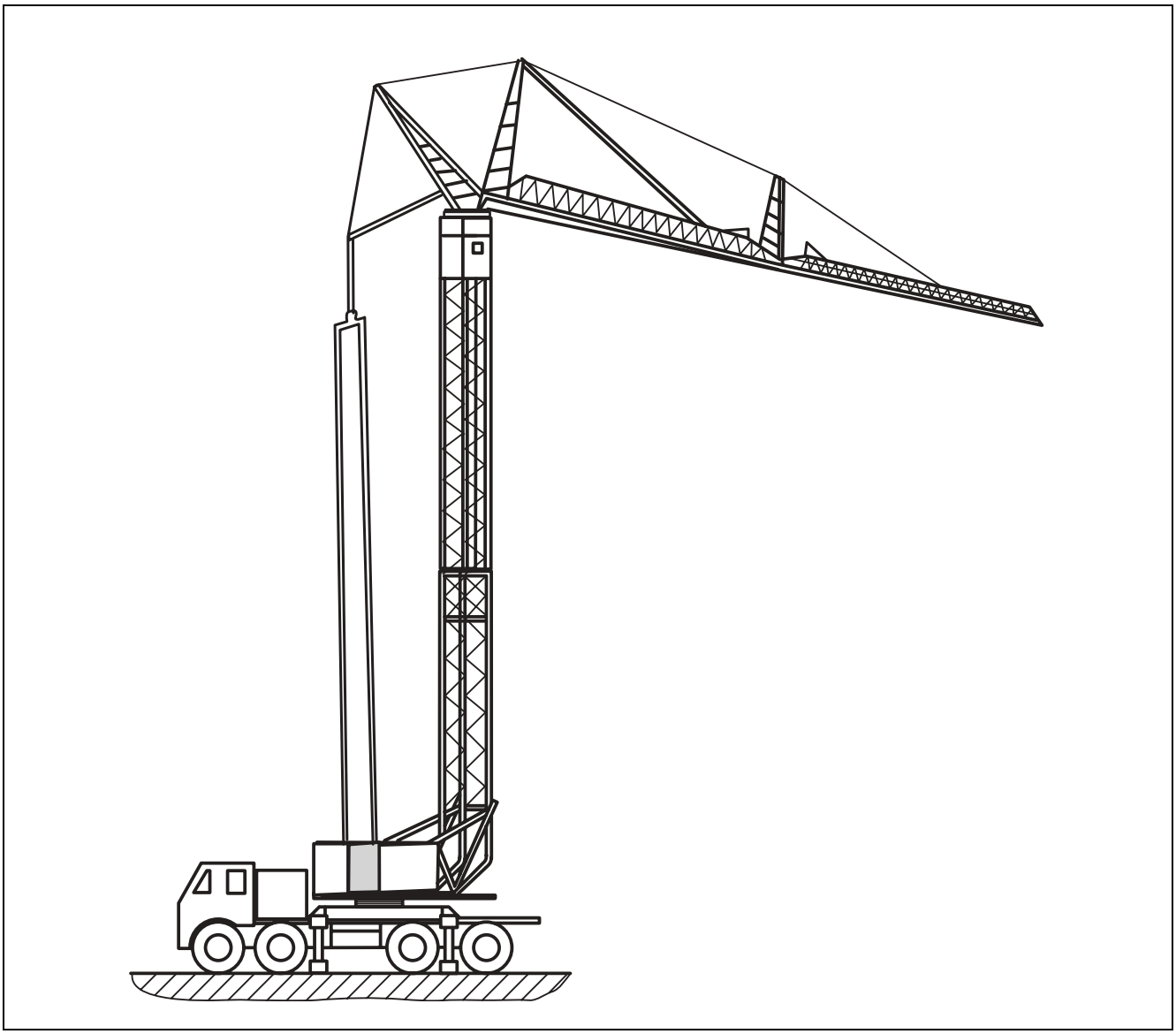
9.5.3 Lorry mounted tower crane

NOTE A lorry mounted tower crane is illustrated in Figure 7.

Figure 7 **Lorry mounted tower crane**



A lorry mounted tower crane is mounted on a truck or lorry chassis. These are particularly suitable when considerable inter-site mobility is required. Extra care should be taken in ensuring that outriggers, jacks, etc., are adequately supported for their imposed loads.

9.5.4 Wheel mounted tower crane

Some very small capacity tower cranes are available on trailer mounts with pneumatic tyres. These machines need to be towed into position and should be properly mounted on their outriggers or jacks before erection or use. The manufacturer's erection instructions should be scrupulously observed and if the operator is to erect and dismantle this type of crane, he or she should be specifically trained and have the attributes of an erector (see **7.2.10**).

9.5.5 Crawler mounted tower crane

Some tower cranes mounted on a crawler base have means of self-levelling. They are equipped with a sensing device to detect verticality. The self-levelling function has a limited range of correction and great care should be taken when travelling over uneven ground. Crawler mounted cranes without self-levelling should not be moved over uneven ground when erected.

9.5.6 Micro tower crane

Micro tower cranes are tower crane units complete for mounting on the top of either a special mast or a hoist mast. They usually have a radius of approximately 6 m, a rated capacity under 1 000 kg and are remote controlled. Micro tower cranes are generally used for offloading materials and placing within a limited area of a building.

9.5.7 Remote controls

NOTE Remote controls have one main advantage in that the crane operator can be at a point of safety when the crane is in use, especially during overload testing.

Where cranes are available with remote controls, care should be taken in their use for the following reasons.

a) The crane operator could be at risk of tripping and falling if they are trying to move around the site over uneven ground whilst concentrating on controlling the crane.

b) The crane operator has no feel for the machine and could, under certain circumstances, be tempted to handle the machine more dangerously than if the crane were operated via a cabin control.

c) Infra-red remote control can be unreliable on tower cranes if the receiving sensor rotates with the crane and thus loses alignment with the transmitter.

10 Safety

NOTE This clause includes information on electrical safety and lightning protection.

10.1 General

The person or organization having overall control of the place of work and the employers of personnel involved in the lifting operation have the responsibility for safety during lifting operations. In order that this responsibility can be effectively discharged, the appointed person (see **4.3**) should be given the necessary authority to ensure that adequate systems to achieve safety are in operation. Safety matters relating to lifting operations include the use, maintenance, repair and renewal of safety equipment and the instruction of, and allocation of responsibilities to, the various personnel in relation to the equipment.

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10.2 Identification of person directing crane movements

The person directing crane movements (slinger or signaller) should be easily identifiable to the crane operator, for example by wearing high visibility clothing or by using radio call signs.

When choosing high visibility clothing, backgrounds, type of illumination and other relevant factors should be taken into account.

10.3 Personal safety equipment

The appointed person should ensure that:

a) any personal safety equipment identified by the risk assessment (see **6.2**) is provided, such as helmets, safety spectacles, fall protection equipment, safety boots and ear defenders;

b) equipment is inspected before and after use and maintained in good working order or replaced where appropriate;

NOTE Further information on selection, use and maintenance of personal fall protection systems and equipment is given in BS 8437.

c) a record of inspection and repairs is maintained where appropriate.

Certain safety equipment, for example helmets, safety spectacles and fall protection equipment, can deteriorate with age and should therefore be considered for renewal periodically. Damaged safety equipment should be replaced immediately.

Personnel working on tower cranes should wear suitable footwear for climbing structures. Helmets with chin straps should be used when working at heights.

NOTE The Health and Safety at Work Act [5] and the PPE Regulations [13] require that employees cooperate with their employer and use and report defects of appropriate personal protective equipment provided for their safety.

10.4 Use of personal protective equipment

NOTE Attention is drawn to the Personal Protective Equipment at Work Regulations [13] which require that any PPE provided is used.

All personnel working on, visiting or in the vicinity of the crane should be made aware of the requirements relating to their personal safety and to the use of the personal protective equipment provided.

It is essential that personnel are instructed in the correct use of the appropriate personal protective equipment provided.

10.5 Access and emergency escape

10.5.1 General

Requirements for safe access and means of emergency escape are detailed in product standards such as BS EN 13557 (controls and control stations), BS EN 14502-1 (suspended baskets), BS EN 14502-2 (elevating control stations), BS EN 13586 (access) and prEN 14439. If additional means of access/emergency escape are required on the crane, these should be incorporated only with the agreement of the crane manufacturer or appropriate design authority. All access including that for the driving position(s) of the crane and for inspection, maintenance, repair, erection and dismantling of the crane should be maintained in good condition.

NOTE Attention is drawn to the Work at Height Regulations [14] regarding the provisions for safe access and rescue.

All access ways should be kept clear of obstructions and other hazards.

10.5.2 Boarding and leaving the crane

If it is necessary for personnel to be present on the crane whilst the machine is in use, they should inform the operator.

It is essential that during access by any personnel on a crane in use, including operator changeover, systems of work include suitable isolation/immobilization procedures or devices to prevent persons from being crushed between fixed and moving access structures.

It is recommended that access to tower cranes is prohibited for personnel whose presence is not essential, wherever possible.

Where provision (e.g. locked trap doors) is made to prevent unauthorized access to the crane care should be taken to ensure that emergency escape and rescue from the crane is not impeded.

10.5.3 Crane access

The appointed person should ensure that ladders, rest platforms and other means of access of cranes manufactured after June 2004 are in accordance with BS EN 13586.

The erection supervisor should ensure that access equipment is correctly installed progressively as erection proceeds, so that the erection team have the benefit of their use. Particular attention should be paid to:

a) ladder joint bolts;

b) guard rails, particularly on rest platforms and inspection platforms;

c) access from ground to the foot of the lowest ladder or to the chassis of the crane;

d) access from levels of the construction to the crane;

e) checking all access equipment before handover to the user.

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10.5.4 Jib and counter jib access

Safe access to and along jibs and counter jibs for inspection and servicing should be provided. Where full edge protection is not provided personnel should wear fall protection equipment at all times. Lanyards should be connected to a suitable anchor point at all times and where lifelines are provided, a suitable device should be used in conjunction with the lanyard to permit full passage along the jib without detachment.

NOTE Personal carrying cages attached to the trolley may provide suitable alternative safe access along the jib.

10.5.5 Cab safety

The erection supervisor should verify that:

a) vision panels in the floor of cabs or at the operator's feet, in such a position that they might have to withstand all or part of the operator's weight, are adequately guarded, and that any such guards provided by the manufacturer are in place;

b) window panels in walls of cabs are protected against being knocked outwards to prevent persons falling through the aperture and that any such protection provided by the manufacturer is in place.

10.5.6 Rescue arrangements

Arrangements should be made for the rescue of personnel from the tower crane including:

a) from the cab of the crane in the event of a medical or other emergency;

b) if a person wearing fall arrest equipment falls from the jib and is left suspended below the jib.

NOTE The Emergency Services cannot be relied upon for rescue of personnel from tower cranes as there is a wide variation in resources for rescue from height across the UK.

10.6 Fire extinguishers

Fire extinguishers should not be provided or used in the cabs of tower cranes as the confined nature of such cabs exposes the user to the risk of suffocation.

10.7 Limiting and indicating devices

10.7.1 General

The correct operation of all limiting and indicating devices should be verified regularly and they should be maintained in good working order in accordance with the manufacturers' instructions.

NOTE Limiting and indicating devices are described in BS EN 12077-2 which came into effect on 15 November 1999.

10.7.2 Level indicators and inclinometers

Where fitted, crane level indicators and inclinometers should be used in accordance with the instruction manual and maintained in good working order.

10.7.3 Wind-speed indicating and monitoring devices

It is essential that tower cranes are fitted with anemometers or other wind-speed monitoring devices. These should have their indicators located in clear view of the crane operator.

The correct operation of these devices should be determined regularly and they should be maintained in good working order. The sensor of the indicator should be positioned so that it can measure air flow uninterrupted by the crane or adjacent structures. Sensors are often positioned on the highest point of the crane.

After installation the wind speed monitoring device should be checked against a calibrated hand held anemometer to confirm the device is functioning correctly.

NOTE The operator uses the information from the anemometer in making a judgement of safe operating windspeed depending on the size and nature of the load being lifted. This may be below the maximum in-service windspeed specified by the crane manufacturer.

10.7.4 Working space limiter (zoning device)

A working space limiter should be fitted to prevent a fixed load attachment and/or parts of the crane from entering a prohibited space.

10.7.5 Anti-collision device

An anti-collision device may be used to prevent a fixed load attachment and cranes or parts of cranes from colliding when they are manoeuvred simultaneously in the same space.

These devices are a useful aid to the operator when operating on multi crane sites but should not be relied on exclusively in place of the primary safe system of work including the crane coordinator, operator vigilance and crane to crane communication using anti-collision radios (see **16.2**).

10.7.6 Machinery guarding

All machinery guarding should be properly fitted whenever the crane is in motion or use and maintained in good condition.

NOTE Attention is drawn to PD 5304, ISO 11660-3 and prEN 14439.

10.8 Other safety provisions

10.8.1 Electrical installations

Tower crane electrical installations should conform to BS 7671.

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10.8.2 Lightning protection

NOTE Additional information on lightning protection is given in BS 6651 and BS 7430.

BS 6651 indicates that as tower cranes are continuous metal structures, in the event of a lightning strike the structure provides an adequate conducting path to earth. To ensure an adequate earth is achieved the resistance path between the bottom of the tower and earth should be measured and it is preferred that it does not exceed a value of 10Ω.

If the resistance to earth exceeds 10Ω, the crane base should be bonded to a suitable earth network via a single core cable of not less than 70 mm^2 cross sectional area and the earth resistance measured again to ensure that it has been reduced to an acceptable value.

In the event of a lightning strike the crane should be thoroughly examined before being returned to service, to ensure that damage has not occurred to the crane or any of its components including the slew ring, safety and control systems.

10.8.3 Base ballast

When concrete ballast needs to be provided, particularly in the case of new tower cranes, it is important that the ballast should either:

a) have been constructed in accordance with the crane manufacturer's design and specification; or

b) be of a design which has been approved by the crane manufacturer, and effectively secured.

Only ballast blocks having markings showing their correct weight should be used.

The lifting points on ballast blocks should be inspected regularly to ensure that they have not deteriorated and are fit for use.

10.8.4 Counterweight ballast

Counterweight ballast should be constructed and marked in accordance with **10.8.3**. Since the counterweight ballast is at height and the blocks have a tendency to rub together during crane operation, precautions should be taken to prevent spilled concrete from falling (for example, by containment in a metal box or frame).

10.8.5 Travel alarms

Rail mounted tower cranes should be fitted with an audible travel alarm.

10.9 Documentation

10.9.1 Rated capacity charts

Readily understandable rated capacity charts applicable to the various specified operating conditions of the crane should be prominently displayed to the operator.

NOTE Operation of the crane outside these parameters even in an unloaded situation could be dangerous.

10.9.2 Instruction manuals

Instruction manuals in appropriate language(s), containing adequate information on the erection, use, alteration and dismantling of the crane should be kept readily available at the location of the crane.

10.9.3 Reports of thorough examination/test certificates

All current reports of thorough examination and any current test certificates for cranes and accessories for lifting should be kept readily available.

10.9.4 Records

Records should be maintained for each crane that are sufficient to enable the condition of the crane to be determined and its fitness for further operation to be properly assessed.

The records should include the following:

a) technical information including maintenance instructions and performance data provided by the manufacturer;

b) records of reports of thorough examinations, any test certificates and records of inspections, including ropes (see BS 7121-2), carried out on the crane (whether statutory or not);

c) records of significant repairs and modifications to the crane including renewal of major parts and confirmation of completion including signatures of responsible person(s);

d) details of occurrences that are of more than short-term relevance [see **14.4**c), d) and e)];

e) hours worked.

Except where specific forms are required by legislation, the format in which records are kept is not important. Whatever method is used should be adequate to ensure that the records allow a relevant and coherent history of the crane to be readily retrieved. The records should be clearly identifiable with respect to the crane to which they refer.

10.9.5 Erection/dismantling and transport

All stages of transportation, erection and dismantling of tower cranes should be thoroughly documented from initial enquiry to the final acceptance by the user organization.

10.9.6 Operators' documentation

Records should be kept of tower crane operators' training and experience, including such certificates of training as are available.

10.9.7 Medical records

Records should be kept of any medical examination for lifting operations personnel.

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10.9.8 Plans and method statements

The plan or method statement for the erection of tower cranes should be retained throughout the duration of a crane's service on any one contract, together with calculations and drawings for the tower crane base.

NOTE It might be necessary to refer to these in the event of a change of construction in the course of the contract requiring alterations to be made to the crane.

10.10 Operator working hours and resources

Planning should take account of the effect that long working hours can have on the concentration of personnel engaged in the operation of tower cranes and ensure that the work is adequately resourced to allow rest breaks to be taken. Table 1 gives the minimum number of operators required for continuous single shift operation of a given number of tower cranes.

Table 1 **Minimum number of operators required for continuous single shift operation of tower cranes**

Number of tower cranes	Number of operators
1	2
2	3
3	5
4	6
5	7
6	9

NOTE Attention is drawn to the requirements of the Working Time Regulations 1998 [15].

11 Siting of cranes

11.1 General

NOTE 1 Detailed guidance on the siting of tower cranes is given in CIRIA publication C703 [12].

NOTE 2 Additional recommendations for the installation and use of self-erecting tower cranes are given in Annex A.

Siting of the crane should take account of all the factors that could affect its safe operation, particularly the following:

a) the crane standing and support conditions;

b) the presence and proximity of other hazards;

c) the effect of wind during in-service and out-of-service conditions;

d) the adequacy of access to allow the placing or erection of the crane in its working position and for dismantling and removing the crane following completion of lifting operations.

11.2 Crane standing or support conditions

NOTE Guidance on the assessment of ground conditions is given in CIRIA publication C703 [12].

The appointed person should ensure that the loads imposed by the crane can be sustained by the ground or any means of support, by obtaining the assessment of a competent person.

The loads imposed by the crane should be obtained from the crane manufacturer or other authority on crane design and construction. The loadings should include the combined effects of the following:

a) the dead weight of the crane (including any counterweight, ballast or foundation where appropriate);

b) the dead weight of the load(s) and any accessories for lifting;

c) dynamic forces caused by movements of the crane;

d) wind loadings resulting from wind speeds up to the maximum permitted, taking into account the degree of exposure of the site (see BS 6399-2).

It is likely that in-service conditions produce the greater imposed loading but out-of-service and erection/dismantling conditions should be taken into account.

The vertical and horizontal forces are unlikely to be uniformly distributed and an allowance should therefore be made for these and for any other unpredictable effects.

The appointed person should ensure that the ground or any means of support is such that the crane can operate within the levels and other parameters specified by the manufacturer.

11.3 Proximity hazards

11.3.1 General

Consideration should be given to the presence of proximity hazards such as overhead electric lines or cables, nearby structures, other cranes, vehicles or ships being loaded or unloaded, stacked goods and public access areas including highways, railways and rivers.

Where any part of the crane or its load cannot be kept clear of such hazards the appropriate authority should be consulted.

The danger to or from underground services, such as gas mains or electric cables, should not be overlooked. Precautions should be taken to ensure that the crane foundation is clear of any underground services or, where this is not possible, that the services are adequately protected against damage.

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At any place where a crane or its load passes an obstacle, the following points apply.

a) Where practicable, the crane path should be clearly defined by marking to ensure that it is kept free from obstruction, and a clearance of not less than 600 mm should be arranged between any part of the crane and any obstacle. Where it is not reasonably practicable to achieve this clearance, effective precautions should be taken to prevent access to any trapping hazards.

b) Where goods are regularly stacked near a crane, boundary lines for the stacking of goods should be permanently marked on the ground.

Where tower cranes inter-arc, a vertical distance should be maintained to prevent collisions. This distance should be either:

1) a minimum clearance of 3 m; or

2) a minimum clearance of 600 mm plus the manufacturer's deflections where full details are available from the manufacturer.

*NOTE Additional recommendations covering clearances are contained in **10.7.4.3**.*

11.3.2 Overhead electric lines and cables

Many fatal accidents have occurred due to some part of a crane, including rope, slings or load, touching, or even coming near to, overhead electric lines or cables. Where the cables form a proximity hazard and it is reasonably practical to turn the power off, steps should be taken by the appointed person to isolate the power.

Where this cannot be done the appointed person should ensure that the guidance given in HSE Guidance Note GS 6 [16] is followed. All distances should be measured at ground level from a position estimated by eye to be vertically below the outermost conductor at a tower or pole position and should include an allowance for the load.

WARNING. All overhead lines and other electrical apparatus should be treated as live unless declared "dead" and "safe" by the line operator. If in doubt, seek advice.

A notice bearing the following wording should be placed in the cab of all cranes likely to work in the vicinity of overhead electric lines or cables.

> "If machine makes contact with live electric line or cable, observe the following precautions.
>
> a) Remain inside cab.
>
> b) Warn all other personnel to keep away from crane and not to touch any part of the crane, rope or load.
>
> c) If the machine cannot be moved away, remain inside the cab. If possible, get someone to inform the electricity supply authority at once. Take no action until it has been confirmed that conditions are safe.

d) If it is essential to leave the cab because of fire or some other reason, jump clear as far away from the crane as possible. Do not touch the crane and the ground at the same time.

e) Inform the responsible engineer of the works or authority concerned of the situation immediately and until assistance is received someone should remain near the crane to warn of the danger."

Devices are available that are designed to be fitted on cranes to give warning when the crane comes within a predetermined distance of overhead electric lines and cables. Such devices are not recommended and should not be considered as a substitute for a safe system of work.

11.3.3 Crane control in the vicinity of aerodromes/airfields

The appointed person should consult the aerodrome/airfield manager for permission to work if a crane is to be used within 6 km of the aerodrome/airfield and its height exceeds 10 m or that of surrounding structures or trees, if higher. Restrictions could be placed on the overall height of the crane and there could be a requirement to fit warning (obstacle) lights to the top of the crane. Further details are contained in *Cranes and planes – A guide to procedures for operation of cranes in vicinity of aerodromes* [17].

NOTE The Air Navigation Order [18] makes it an offence to act recklessly or negligently in a manner likely to endanger aircraft.

11.4 Ground conditions

NOTE Additional recommendations on ground conditions and foundations are given in CIRIA publication C703 [12].

Where tower cranes are to be erected close to the foundations of existing buildings or buildings to be constructed, the appointed person should ensure that the ground is consolidated as required by the designer of the crane base.

Where disturbance to the ground has occurred in the construction of adjacent foundations, a retaining wall should be constructed or deeper foundations used for the tower crane.

11.5 Tower crane foundations

11.5.1 Expendable base blocks

Minimum dimensions for any expendable base block together with the overturning moment and other loadings during operation and out-of-service conditions should be as specified by the crane manufacturer.

Having obtained from the crane manufacturer the loads imposed by the crane (noting that these could be net and exclusive of any impact of safety factors), the foundation should be designed by a competent engineer so that the ground bearing capacity is not exceeded, including that caused by overturning moments.

Where the base design limits the free standing height of the crane, the maximum permitted free standing height should be marked at the base of the crane and entered into the documentation.

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11.5.2 Rail tracks for tower cranes

NOTE Rail track requires expertise in its design, layout and installation, particularly if it is to be curved.

Rail track should be made of suitable materials and strict control should be exercised to ensure that it is not in any way abused.

The area between the tracks should never be used for the storage of materials or for access to, from or across the site. The total area of the rail tracks in use should be fenced off to prevent access by unauthorized persons.

If there needs to be a point at which vehicles cross the rail track, this should be carefully controlled to prevent accidental collision, and precautions should be taken to ensure that the track is not overloaded by the vehicles crossing it.

The gauge of rail tracks should be maintained by suitable means, for example tie bars.

Rail tracks should not be welded or subjected to heating.

End stops or buffers should be positively fixed (bolted or pinned) to the rail and precisely adjusted to ensure that the crane makes contact with both sides simultaneously. These end stops should be shock absorbing or sprung, and should be moved hard against the crane chassis if the machine is to be used in a static position for any period of time. Rail stops should not be taken into account when calculating the stability of the machine.

Where two or more tower cranes run on the same track physical stops should be provided to segregate the track and prevent adjacent crane structures or loads colliding.

Rail clamps which the crane manufacturer might provide to prevent the crane from rolling along the track in storm conditions should be fitted whenever the machine is out-of-service. If clamps are not supplied, adequate means should be adopted to achieve the same result.

Rail tracks of all types require periodic inspection, and if any defect or out-of-level becomes apparent, corrective action should be instigated immediately.

Attention should be paid to the design and layout of the power supply (trailing cable) for travelling tower cranes to ensure that it is protected from damage.

11.5.3 Special base

Where the particular application calls for a special base arrangement, for example structural steelwork, then the appointed person should ensure that the base is:

a) designed by a competent engineer, allowing for any appropriate factors (e.g. impact, dynamic), with the details of the design verified by a competent third party;

b) constructed in accordance with the design.

12 Erecting, dismantling and alteration of height

12.1 Planning

12.1.1 General

Effective planning of a tower crane erection, dismantling or alteration is essential if the operation is to proceed safely, effectively and without incident.

Erection, dismantling and alteration of height of tower cranes should not be undertaken after dark.

NOTE Past experience has shown that artificial light is inadequate for the task to be carried out safely.

12.1.2 Working hours and resources

Planning should take account of the effect that long working hours can have on the concentration of personnel engaged in the installation of tower cranes and ensure that the work is adequately resourced to allow rest breaks to be taken.

Allowance should be made for unforeseen stoppages and delays. See **12.1.7.19** and **12.8**.

NOTE Attention is drawn to the requirements of the Working Time Regulations 1998 [15].

12.1.3 Liaison with principle contractor and others

Planning for the erection, dismantling or alteration of a tower crane should begin at the earliest possible moment, often at the pre-construction stage. This ensures that operation can be phased effectively with other construction activities and that the requirements of adjacent occupiers such as railways or airports can be accommodated.

It is essential that the Principle Contractor on a site is fully involved in the planning as they have overall responsibility for ensuring that the operations are carried out safely and without incident. They are also able to provide access to the Permanent Works designer in cases where the building structure is being used to absorb the loads from the tower crane base or ties supporting an external tower crane or the collars of an internal tower crane.

12.1.4 Site visits

As part of the planning process it is essential that the person carrying out the planning visits the site at which the operation is to be carried out. This enables them to ensure that they are familiar with the constraints of the site such as road access for crane components and installation equipment, laydown areas, other cranes on site, oversailing cranes on adjacent sites, adjacent railway lines and other site activities that could impinge on the erection, dismantling or alteration operation.

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Sites with restricted space can impose additional constraints on the installation which should be taken into account in the risk assessment and method statement, for example jib installed in two parts, need to reduce component weight, assembling test weights.

12.1.5 Structural considerations

Tower crane installation generally involves the design and construction of a suitable base to transfer the loads and moments from the crane tower into the ground or another structure. As part of the planning process it is important that the design and construction of the base is taken into account, together with the connection to ground or adjacent structure. All design work should be carried out by a competent engineer.

12.1.6 Risk assessment

As part of the planning process a risk assessment should be carried out to identify the hazards associated with the proposed operation. The assessment should evaluate the risks involved and the nature and extent of any measures required to eliminate those risks or reduce them to an acceptable level.

For tower crane installation operations generic risk assessments are unlikely to be sufficient as every site and installation operation has hazards that are unique to that situation and should be taken into account in the assessment. The results of the risk assessment should be recorded in writing and made available to the person responsible for the preparation of the method statement.

12.1.7 Method statement preparation

12.1.7.1 General

Once the risk assessment has been carried out, the appointed person should ensure that a full method statement document is prepared, detailing the safe system of work for the installation operation. The appointed person may either prepare the method statement himself or delegate it to another person who has sufficient knowledge and experience to undertake the task. If the task is delegated to another person the appointed person should review and approve the method statement before the operation takes place.

The method statement should address the issues given in **12.1.7.2** to **12.1.7.21**.

12.1.7.2 Issue and revision

The front cover of the document should clearly identify the site, crane, task to be undertaken, author, date of original issue, issue number, date of any subsequent revisions and distribution list.

Any changes to the method statement following its initial issue should be recorded by a revision to the document and the document reissued.

The Appointed Person should ensure that all persons on the distribution list are in receipt of the latest version before the start of the operation.

12.1.7.3 Tower crane configuration

Details of the crane configuration before and after the operation to be undertaken should be recorded.

12.1.7.4 Programme

A detailed programme should be included indicating the tasks to be achieved each day, with a start and finish time for each task, together with the configuration of the crane at the end of each days' work (see **12.1.2**).

12.1.7.5 Responsibilities

The responsibilities for each part of the preparation and execution of the operation should be clearly stated (e.g. site access, exclusion zones, base preparation for mobile crane, tying points, oversailing cranes). The appointed person should be clearly identified.

12.1.7.6 The erection team

The composition and responsibilities of the erection team should be detailed, together with the duties of each member of the team (see **12.5** and **12.6**).

12.1.7.7 Briefing arrangements

The arrangements for a full briefing of the erection team on the contents of the method statement and any sections of the manufacturer's manual to which it refers should be detailed. The briefing should take place on site before the start of the installation operation and should be given by either the appointed person, if they are on site, or the erection supervisor. The person giving the briefing should confirm that they are in possession of the latest revision of the method statement and manufacturer's manual before the briefing.

The aim of the briefing is to ensure that each member of the erection team is clear on the overall objectives of the task and their role in achieving that objective. Particular emphasis should be placed on contingency arrangements and those being briefed should be encouraged to ask questions and seek clarification on any points on which they are not clear.

All those attending the briefing should be asked to sign a declaration confirming that they have attended and understood the briefing.

12.1.7.8 Preparation of components and equipment

Arrangements for the off-site preparation of crane components together with equipment such as climbing frames, power packs and torque gear should be detailed, together with details of any on-site assembly and inspection required before climbing begins. See **12.7**.

12.1.7.9 Transport of components to and from site

Arrangements for the transport of components and equipment should be detailed, taking into account the sequence in which they are required, to ensure that the installation programme is not delayed. These arrangements should take into account any parking restrictions both on site and in the surrounding area.

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12.1.7.10 Access

Details of access to the site for both the vehicles involved in transportation of tower crane components and installation equipment as well as the crane(s) used for erection should be recorded. This should include agreed access routes, taking into account ground conditions and also the need for vehicle marshals (banksman).

12.1.7.11 Proximity hazards

Details of any proximity hazards that might impinge on the operation should be recorded, such as railways, roads, public access, aircraft or other cranes.

12.1.7.12 Craneage arrangements

NOTE See BS 7121-3 for guidance on the selection, siting and use of mobile cranes.

The arrangements for any cranes required to assist with the erection, dismantle or alteration operation should be detailed. These might be either cranes already on site (tower, or mobile) or mobile cranes brought to site specifically for the task to be undertaken. These arrangements should include the assessment of ground conditions, preparation of suitable outrigger foundations and any road closures.

Selection of these cranes should take into account that when removing components from a height the assisting crane is carrying the entire load with no opportunity for safely replacing it once the attachment pins have been removed. In this case it might be desirable for the crane to have some excess capacity to allow for any error in the slinging of the component concerned or its sudden release.

12.1.7.13 Protection from falling objects

Arrangements for the protection of persons from falling objects in the area below the installation operation should be detailed. The primary method of control should be the establishment and enforcement, by the Principal Contractor, of exclusion zones around the base of the crane. Secondary control measures could include the use of lanyards for hand tools, toeboards and mesh panels on working platforms.

12.1.7.14 Protection from falls from height

Arrangements for the protection of those involved in the installation operation from falls from height should be detailed. This should include adequate edge protection on working platforms or the use of fall protection Personal Protective Equipment (PPE) such as full body harnesses and shock absorbing lanyards. If fall protection PPE is used the method statement should refer to the arrangements for ensuring that the PPE is appropriate and regularly inspected. See **10.4** and **10.5.6**.

12.1.7.15 Communication

Arrangements for ensuring that all members of the erection team can effectively communicate at all times during the installation operation should be detailed.

Communication is normally required between personnel on the ground, personnel on the tower crane structure and the operators of any other cranes involved. This is normally achieved using hand held VHF/UHF radios and arrangements should be made to ensure that good communication is maintained at all times. These might include choosing a unique frequency to avoid interference from other sites, ensuring that batteries are fully charged and that spare handsets are available in case of breakdown.

12.1.7.16 Weather forecasting and monitoring

Tower crane installation operations can only be carried out in wind speeds below the limit set by the crane manufacturer. Arrangements should therefore be detailed to obtain accurate weather forecasts in the period leading up to the start of the operation. These enable the Appointed Person and the Erection Supervisor to decide if the operation may proceed. If the programme is of several days duration, daily forecasts should be obtained to ensure that the crane can be secured in a suitable configuration if high winds are indicated (see **12.8**).

During the installation operation the wind speed should be periodically monitored using a calibrated handheld anemometer.

12.1.7.17 Installation method

Details should be given of the procedure for carrying out the task to be undertaken. At the least this is by reference to specific sections of the manufacturer's installation manual for the individual crane (see **12.2**).

12.1.7.18 Information

Any information required by the team carrying out the operation in addition to the method statement should be detailed. This should include the availability on site of a comprehensive manufacturer's erection/dismantling/operation manual. The manual should be specific to the individual tower crane and in the language most readily understood by the erection team (see **12.2**).

12.1.7.19 Contingency arrangements

Contingency arrangements should be detailed for the occurrence of foreseeable circumstances that might affect the safety of the operation being undertaken (e.g. power failure, equipment failure, increase in wind speed, personnel injury). This should include arrangements for the notification of problems to the Appointed Person if he is not present on site during the operation and the leaving of the part assembled crane in a safe condition.

Reference should also be made to site specific emergency procedures.

12.1.7.20 Thorough examination including testing

The arrangements for carrying out a thorough examination and proof load test, after the erection or alteration operation has been completed and before the crane is returned to service, should be detailed.

12.1.7.21 Commissioning the crane

Arrangements for commissioning the crane and handing it over to the site following the successful completion of the thorough examination should be detailed.

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12.2 Manufacturer's erection and dismantling instructions

A copy of the crane manufacturer's instructions should be available on site and closely followed. Any departure from the specified sequential procedure should be approved by the designer or another competent engineer, to ensure stability of the crane and that structural and mechanical parts are not subjected to excessive loading.

Before starting installation operations the erection supervisor should ensure that the erection/dismantling manual is appropriate to the particular crane, bears the crane manufacturer's serial and type numbers and the owner's identification. Manuals should have an issue date and reference so that the erection supervisor can ensure that he has the latest issue incorporating the latest revisions.

Manuals sometimes deal with dismantling procedures by the simple statement that they are the reverse of erection procedures. The appointed person should ensure that such a statement is correct and if there is any doubt obtain further information from the tower crane manufacturer.

12.3 Components and materials

NOTE This subclause includes identification of components and materials.

12.3.1 Components

All major components that form part of a crane and are dismantled for transportation, particularly those that are load bearing or ensure the stability of the assembled crane, should carry a clear identification mark.

Diagrams and drawings in the crane instruction manual relating to erection and dismantling should use the same system of marking and show the correct location and orientation of components.

NOTE LOLER [1] states that it is necessary to identify any part of a crane jib that can be removed so as to indicate the crane of which it is a part.

Care should be taken to avoid a mismatch of thread forms of fasteners (nuts and bolts), for example between imperial and metric.

The interchange of structural components between one model of tower crane and another may occur if the manufacturer has given approval. Having carried out such an interchange, a tower crane should be retested in its new combination, and the interchanged parts should be specified on the test certificate.

When a tower crane is erected using components from two or more manufacturers, it is essential that the written agreement of at least one of the manufacturers, where they remain available, is obtained before erection starts. In the absence of the manufacturers the combination of components should be approved by a competent design authority.

12.3.2 Materials

Most tower crane parts are made from special materials and may only be repaired or replaced in accordance with the manufacturer's specification. Such components should be marked to indicate this has taken place.

Welding or other heat treatments should be carried out as specified by the manufacturer.

Nuts and bolts manufactured from high tensile steel or other special steels carry markings so that they can be distinguished from other nuts and bolts. It is essential that the re-use of high tensile bolts is in accordance with the manufacturer's conditions.

High strength friction grip bolts should not be reused once a joint has been dismantled.

Bolts used to secure slew races should be renewed whenever they are removed. They should only be tightened in accordance with the manufacturer's instructions.

12.4 Electrical supply

The installation of electrical supplies for tower cranes should conform to BS 7671. The following points are important.

a) Electrically operated cranes should have an effective earth connection. In the case of cranes mounted on rails, at least one rail track should be electrically bonded at each rail joint and the track should be effectively earthed. Crane wheels should not be used for earthing the crane.

b) The crane structure, motor frames and conducting cases of all electrical equipment, including metal conduit and cable guards, should be effectively and directly connected to earth. See **10.8.2**.

c) The characteristics of the power supply and of the crane equipment should be checked for compatibility before connection.

d) Cables providing power to the crane should be protected from mechanical damage by one or more of the following means:

   1) running in conduit, trunking or on trays;

   2) being clipped to a structure in a position where they are protected from mechanical damage;

   3) being of armoured construction.

Where conducting material is used for protection, it should be bonded to earth at each end. In no case should the protection be used as an earth conductor.

Where practicable, the power supply to a travelling crane should be through a cable winding drum or a properly installed, insulated and protected collector system.

Care should be taken to ensure that any trailing cable is not damaged during operational movement or when the crane is travelling. The travel distance should be well within the length of the trailing cable.

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In addition to any isolator within the crane that is capable of cutting off the electrical supply to the crane motions, there should be an identified isolator remote from the crane that can be used to cut off the electrical supply to the crane itself. All isolators should be capable of being locked in the off position and should be identified with the individual cranes whose power supplies they control.

12.5 Personnel

The erection, dismantling and alteration of the height of tower cranes should be carried out by specialist personnel under the continuous control of the erection supervisor and in accordance with the manufacturer's instructions. This supervisor should be given the authority to stop the operation if he or she considers such action is warranted by ground conditions, weather, obstructions or any other cause.

The erection supervisor should be in close liaison with the site management and should carefully consider any comments or warnings that management, any members of the site team, or any other appropriate person or body make.

12.6 Control

In the case of erection and dismantling of tower cranes, the person appointed to control the lifting operation should also take control of any additional crane which might be used in the course of such an operation, and be familiar with details of that crane, to facilitate the carrying out of the duties detailed in **4.2** and **4.3**.

He should also ensure that the operation is under the constant supervision of the crane erection supervisor.

12.7 Inspection before erection

NOTE Under certain circumstances it might be advantageous to carry out an inspection of the tower crane before it is delivered from the supplier to the user.

All parts should be inspected prior to erection to ensure they belong to the crane being erected and are in good condition, free from defect.

Slinging points should be identified for all components.

12.8 Weather

Tower cranes should not be erected or dismantled in weather conditions likely to affect the stability of the crane, e.g. high winds (reference should be made to the manufacturer's instructions for the maximum permissible wind speed for these particular operations), or under conditions of impaired visibility, e.g. fog.

NOTE More stringent restrictions on wind speed apply to very high cranes, further information can be obtained from the crane manufacturer.

Installation work should be avoided if the conditions (e.g. ice on component parts and walkways) are likely to endanger the erectors.

12.9 Working area and exclusion zones

The area in which a tower crane is to be erected or dismantled should be roped or fenced off and all personnel not immediately connected with this duty should be excluded. See **12.1.7.13**. The size and extent of the exclusion zone should be the subject of a site specific risk assessment.

13 Tower crane climbing

13.1 General

Tower crane climbing is a specialized technique used in the installation of tower cranes. Successful climbing depends on detailed planning and effective team work by suitably trained and experienced personnel. This clause deals with the matters that need to be taken into account in addition to those in Clause **12** when climbing is being undertaken.

13.2 Basic principles

13.2.1 General

Most tower cranes are initially erected to their full height using another crane, either a mobile crane or another tower crane. This is however not always possible as very tall cranes might require tying to an adjacent structure, often the building they are helping to construct, and consequently need erecting in stages. Additionally, congested city centre sites often do not have sufficient room on which to stand the large mobile cranes required to erect tower cranes to great heights. In these cases the height of the tower crane may be extended using climbing techniques. These fall into two main categories, external (where the tower of a crane outside a building is extended with a jacking system to allow additional tower sections to be inserted), and internal (where the crane tower is supported by the building floors and is jacked up as the building rises). See Figure 8 and Figure 9.

13.2.2 External climbing

When carrying out external climbing, the most common method of increasing the height of a tower crane is by the use of a climbing frame. This consists of a lattice steel frame surrounding three sides of the crane tower, with an opening on the fourth. A hydraulic cylinder(s) allows the frame to be raised or lowered and guide wheels or rollers are provided to keep the frame aligned on the tower. The open side of the frame incorporates means of holding a new tower section prior to raising the climbing frame, moving it into the tower after climbing and then lowering it on to the top of the previous section.

At the start of the climbing process the climbing frame, generally in two parts, is assembled on the crane tower and then lifted to the top of the tower by the crane. Once at the top of the tower the frame is secured to the underside of the crane slewing section. The foot of the climbing cylinder(s) is then located on reaction points on the tower. See Figure 8b.

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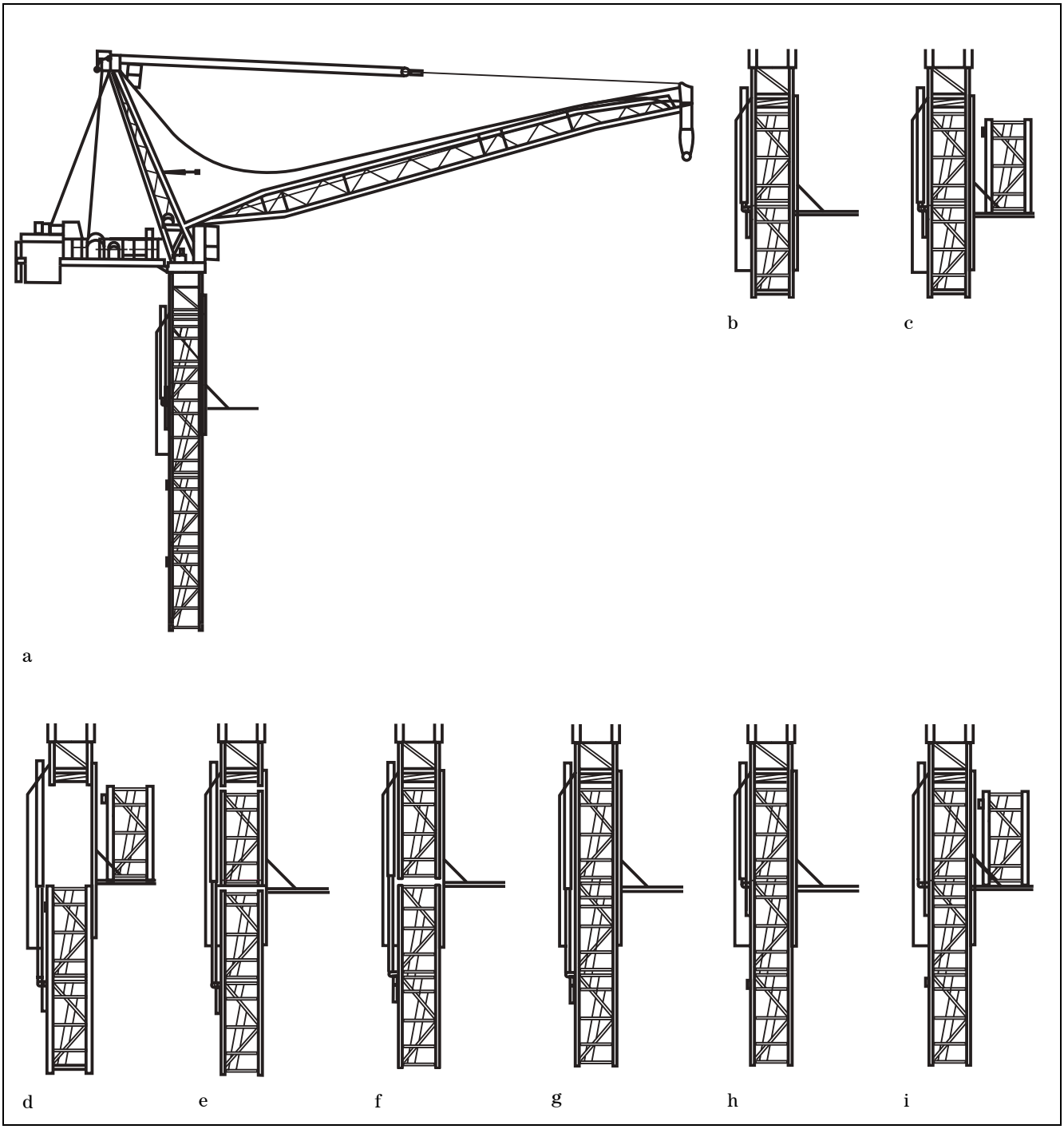
Figure 8 **Typical external climbing sequence**



A tower section is then lifted by the crane and transferred to the climbing frame. The crane is then slewed square with the tower and put in balance to ensure that the overturning moment on the climbing frame is kept to a minimum. Balancing is achieved by either lifting a specified weight (normally another tower section) and moving it to a specific radius or using the self weight of the jib and hook block. This ensures that the superstructure of the crane is balancing about the centre of the climbing cylinder(s). See Figure 8c.

The climbing cylinder(s) is then pressurized to take the weight of the crane superstructure, allowing the fastenings connecting the superstructure of the crane to the uppermost tower section to be removed. Once the fastenings have been removed the cylinder(s) is extended to lift the crane superstructure a sufficient distance to allow a new tower section to be inserted. See Figure 8d. When the climbing frame has been extended sufficiently, the new tower section is pulled into the frame. See Figure 8e. The frame is then lowered until the joints on the crane superstructure engage with the top of the new section. The crane superstructure/tower joints are then secured and the new tower section lifted clear of the transfer device to allow it to be pushed out of the climbing frame. See Figure 8f.

Once the transfer device is clear of the frame, the crane superstructure is lowered to allow the bottom of the new section to engage with the joints of the previous section. When the joints are fully engaged, fastenings are secured to lock them. See Figure 8g.

The climbing cylinder(s) is then retracted and its foot located on the tower reaction points (Figure 8h), allowing the climbing cycle to be repeated. See Figure 8i.

13.2.3 Internal climbing

On a tall structure placing the tower crane outside the building with a tower extending from foundation level to the top of the building can result in a costly tower configuration. It might also require a high capacity crane to place loads in the centre of the building's footprint. As an alternative the crane and its tower can be located inside the building and climbed up inside the structure as construction progresses, using the completed part of the structure to take all the forces generated by the crane. This process is known as "internal climbing".

The crane is supported in collars which surround the tower at two different floor levels, generally about 12 m apart. The lower collar, at the bottom of the tower, takes vertical forces and part of the overturning moment, whilst the top collar takes the horizontal forces of the remainder of the moment. Whilst the crane is working the tower is clamped to both collars allowing the forces generated by the crane to be transferred to the collars and into the building structure, usually via a steel grillage.

To climb the crane up to the next level an additional collar is assembled around the tower at the prescribed distance above the top collar and the climbing supports, up which the crane climbs, are hung from what has now become the middle collar. See Figure 9a. The devices clamping the tower to the collars are released and the crane is climbed to the next level using a hydraulic climbing section at the bottom of the tower which reacts on the climbing supports. Once the bottom of the tower has reached the middle collar, the tower is clamped to the middle and top collars, leaving the bottom collar to be removed and available for the next climb. See Figure 9b.

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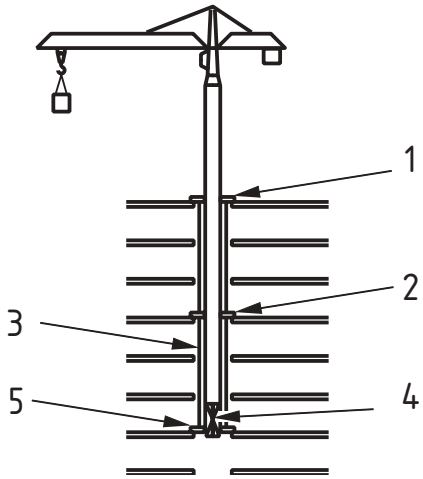
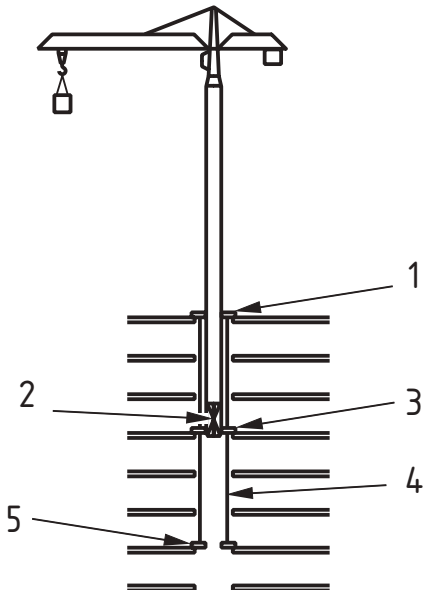
Figure 9 **Typical internal climbing sequence**



Key

1 New top collar (installed before climbing)
2 Middle (previously top) collar
3 Climbing support
4 Hydraulic climbing section
5 Bottom collar

a) Before climbing



Key

1 Top collar
2 Hydraulic climbing section
3 Bottom collar
4 Climbing support
5 Old bottom collar (for removal)

b) After climbing

13.3 Climbing systems

13.3.1 General

Whilst all climbing systems utilize the principles described in **13.2.2** and **13.2.3** the details vary between makes, types and models of tower cranes. The manufacturer's instructions for the specific crane being climbed should be referred to for both the planning and execution of the climbing operation. Some variations between systems are described in **13.3.2** and **13.3.3**.

13.3.2 External

External climbing frames are all basically a steel lattice frame forming a sleeve around the tower with guide wheels or rollers to transfer any horizontal forces resulting from any overturning moment to the tower. The guide wheels or rollers may bear on either the corners or faces of the tower section corner posts.

Lifting of the climbing frame is carried out by a hydraulic cylinder(s) attached to the frame with the free end located on reaction points on the tower. These reaction points are either tower structure members or lugs welded to the tower. On some designs of climbing frame the cylinder(s) has sufficient stroke to lift the crane superstructure the distance required to insert a new tower section. On others a cylinder(s) with a shorter stroke is used in conjunction with a ratchet mechanism requiring the cylinder(s) to be extended and retracted several times to lift the climbing frame the required distance.

On most designs of climbing frame the climbing cylinder(s) is located on one side of the tower but on some it is located centrally, making it easier to balance the crane superstructure.

The means of holding the new tower section on the climbing frame and transferring it in to the tower may either be an overhead runway beam projecting from the climbing frame from which the tower section is suspended or a guided platform on which the tower section is placed.

Climbing frames are generally provided with personnel platforms located at the top and bottom of the frame to provide safe access for the erection team, with connecting ladders between the platforms.

A far less common type of external climbing system has the crane superstructure located on an inner tower which telescopes from an outer tower. Once the inner tower has been extended additional tower sections, in halves, are lifted up and bolted together around the inner tower. The climbing equipment can then be engaged in the new section and the climbing process repeated.

13.3.3 Internal

Internal climbing arrangements generally consist of climbing supports suspended from the top collar and a hydraulic climbing device which lifts the crane up the climbing supports in a series of strokes of the cylinder(s), with a ratchet arrangement to support the crane during cylinder(s) retraction. Climbing supports can be ladders, rods or tubes.

13.4 Planning

13.4.1 General

Effective planning of a tower crane climbing operation is essential if the operation is to proceed safely, effectively and without incident. When planning a tower crane climbing operation the process detailed in **12.1** should be followed in addition to the concerns given in **13.4.2** to **13.4.4**.

13.4.2 Structural considerations

13.4.2.1 General

Tower crane climbing frequently involves tying to an adjacent structure, often the building on which the tower crane is being used for lifting operations. As part of the planning process it is important that the design and fabrication of the ties is taken into account, together with the connection to the structure. The location and structural requirements of internally climbed cranes should also be considered at this stage. All design work should be carried out by suitably qualified engineers.

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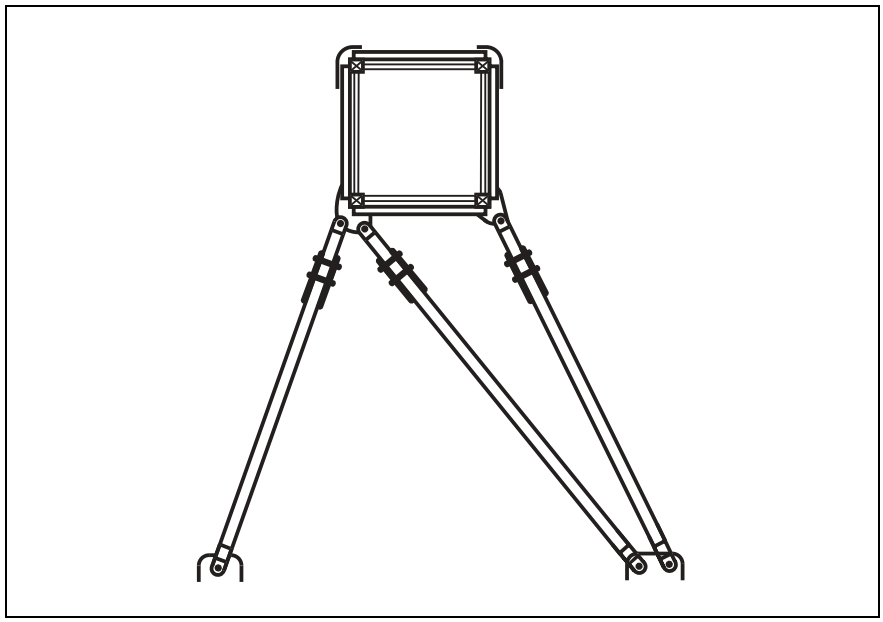
13.4.2.2 External ties

External tower crane ties normally take the form of three steel "legs" which transfer horizontal forces from the crane tower to the adjacent structure. See Figure 10. The legs are triangulated to minimize twisting of the tower and are pin jointed to the tower and structure to eliminate bending from the leg members. The tower is generally surrounded with a "collar" onto which the legs are connected. This collar provides convenient attachment points and ensures that forces are transmitted without local overloading. Certain designs of tower and collar only permit the collar to be located at certain points vertically on the tower and the manufacturer's instructions should be followed.

Figure 10 **Typical tie**



Connection of the legs to the structure is generally made via pin jointed brackets, which are then fastened to the structure. The method of fastening depends on the magnitude of the tie loads and the strength and construction of the structure. Consultation between the designers of the structure and the person planning the climbing operation should take place at the earliest opportunity as substantial internal bracing might be required to transfer the tie forces to a strong point in the structure.

When a tie is installed measures should be taken to ensure that the crane tower remains vertical within the limits set by the manufacturer. Ties should be provided with adjustable length tie legs to enable the tower to be set vertical during and after installation. Guidance on checking of verticality is given in CIRIA C654 [7].

Tower verticality is especially important during climbing as any substantial deviation from the vertical can affect the hook radius specified for balance by the manufacturer.

13.4.2.3 Internal climbing frames or collars

When a tower crane is climbed within a building structure openings are left in each floor to accommodate the crane tower and climbing equipment as it is climbed up the structure. The climbing frames or collars, which serve as guides and reaction points for the crane tower, are located around the periphery of the floor apertures and are either connected directly to the floor slab or more usually to steel grillages connected to the structure. The method of fastening depends on the magnitude of the tie loads and the strength and construction of the structure.

Consultation between the designers of the structure and the person planning the climbing operation should take place at the earliest opportunity as substantial shoring and bracing could be required to safely transfer the collar forces to the structure.

13.4.3 Risk assessment

A risk assessment should be carried out in accordance with **12.1.6** and additionally take into account the particular hazards that are associated with tower crane climbing operations. These hazards might include:

a) collapse due to changing wind loading;

b) collapse due to incorrect balancing of the crane top;

c) collapse due to inadvertent slewing during climbing;

d) loss of support for the climbing frame during jacking;

e) falling from walkways, platforms or ladders on the climbing frame;

f) falling objects;

g) incorrect operation of the climbing frame;

h) mechanical/electrical failure of the climbing frame.

It is essential that the appointed person carrying out the risk assessment has sufficient detailed knowledge of the specific crane and specific climbing equipment to be used in order to identify hazards.

13.4.4 Method statement preparation

13.4.4.1 General

The method statement should be prepared in accordance with **12.1.7** and additionally address the issues given in **13.4.4.2** to **13.4.4.8** associated with tower crane climbing operations.

13.4.4.2 Communication

Arrangements for ensuring that all members of the erection team can effectively communicate at all times during the climbing operation should be detailed (see **12.1.7.15**).

Communication is normally necessary between personnel on the ground, personnel on the climbing frame, the operator in the cab of the crane being climbed and the operators of any other cranes involved.

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13.4.4.3 Weather forecasting and monitoring

Tower crane climbing operations may only be carried out in wind speeds below the limit set by the crane manufacturer (generally 12.5 m/s). Unless specified otherwise this limiting wind speed should be taken as the maximum gust speed. Arrangements should therefore be detailed to obtain accurate weather forecasts in the period leading up to the start of climbing. These enable the Appointed Person and the Erection Supervisor to decide if climbing should go ahead. If the climbing programme is of several days duration, daily forecasts should be obtained to ensure that the crane can be secured in a suitable configuration if high winds are indicated.

Arrangements should also be made to monitor wind speed just prior to and during the climbing operations. This is often achieved by the operator monitoring the tower crane's anemometer and the Erection Supervisor using a calibrated hand held anemometer.

For climbing operations the weather forecasts should be site specific, giving mean and gust wind speeds (at required heights), wind direction and weather for the next five days. This information is obtainable from a number of specialist providers (such as the Met Office). See **13.5.3** for further information on environmental monitoring.

13.4.4.4 Inspection of climbing equipment before and during climbing

Arrangements for the inspection of climbing equipment before climbing starts should be detailed, together with procedures for the reporting of any defects, to ensure that the climbing process is not started with faulty equipment.

Procedures for the monitoring and reporting of defects such as vibration during the climbing process should also be documented.

13.4.4.5 Specific climbing procedures including balancing

The specific climbing procedures for the make, model and configuration of the crane to be climbed should be detailed. If this is by reference to the manufacturer's instruction manual the arrangements for ensuring that a copy of the relevant manual is available on site should be given. See **12.2**.

Particular attention should be paid to the manufacturer's specified arrangements for ensuring that the crane is balanced.

Balancing is often carried out by altering the hook radius about a nominal balance radius detailed by the manufacturer. A +/– tolerance on this nominal figure should be given outside which the climbing team should not go without reference to the Appointed Person.

13.4.4.6 Contingency arrangements

Contingency arrangements should be detailed for the occurrence of any circumstance that might affect the safety of the climbing operation (e.g. power failure, hydraulic failure, increase in wind speed). This should include arrangements for the notification of problems to the Appointed Person if he is not present on site during the climbing operation.

Reference should also be made to site specific emergency procedures.

13.4.4.7 Thorough examination including testing

NOTE See Annex D for guidance on climbing frame thorough examination and checks.

The arrangements for carrying out a thorough examination after installation and overload test, after the climbing operation has been completed and before the crane is returned to service, should be detailed.

13.4.4.8 Commissioning the crane

Arrangements for commissioning the crane and handing it back to the site following the successful completion of the thorough examination should be detailed.

13.5 Climbing process

13.5.1 Briefing of erection team

Once the erection team has arrived on site and before the climbing process is started a comprehensive briefing of all those involved with the climbing process should be carried out by the Appointed Person or Erection Supervisor using the final edition of the method statement. The briefing should cover the contents of the method statement, any sections of the manufacturer's manual to which it refers, and in particular, those features of the operation that are peculiar to the site (e.g. proximity of other cranes, interface with the public, proximity of other trades, noise restrictions, work hours restrictions).

13.5.2 Liaison with site

The company carrying out the climbing operation should maintain a close liaison with the nominated representative of the organization with overall charge of the site (Main Contractor) to ensure that those matters for which the Main Contractor is responsible, such as monitoring of exclusion zones and liaison with other trades, are dealt with effectively.

13.5.3 Environmental monitoring

13.5.3.1 Wind

Tower crane climbing operations may only be carried out in wind speeds below the limit set by the crane manufacture (generally 12.5 m/s). Unless specified otherwise this limiting wind speed should be taken as the maximum gust speed. Wind speeds in excess of the manufacturer's limits can affect the balance, and hence the integrity, of the crane during climbing, as can gusts and shifts in wind direction. Arrangements should therefore be made to obtain accurate site area specific weather forecasts in the period leading up to the start of climbing. These forecasts should indicate wind direction, mean wind speed and maximum gust speed at intervals over a 24 h period. Wind speed increases with height above the ground and as forecast wind speeds are predicted for a specific height above ground level (often 10 m) these should be corrected for the height at which climbing takes place.

These forecasts enable the Appointed Person and the Erection Supervisor to decide if climbing should go ahead. If the climbing programme is of several days duration, daily forecasts should be

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obtained to ensure that the crane can be secured in a safe configuration if high winds are indicated.

Once on site, wind speed should be monitored by the tower crane operator using the anemometer mounted on the crane "A" frame and by the Erection Supervisor using a calibrated hand held anemometer. The supervisor should monitor the wind speed for a period of 15 min before starting the climb to assess the degree of gusting and to ensure that the wind speed does not exceed the manufacturer's limit for climbing.

13.5.3.2 Visibility

Good visibility is required during tower crane climbing to enable the effective monitoring of the climbing process. Climbing should not be carried out when visibility is poor or after dark.

13.5.4 Monitoring of exclusion zones

An important part of the safe system of work for climbing tower cranes is the protection of persons below the crane by the establishment and enforcement of exclusion zones. These ensure that all persons not directly concerned with climbing operation are excluded from the area at risk from falling objects. However once established it is important that these are monitored to ensure that unauthorized persons do not enter the zone. The responsibility for this monitoring should be established at the planning stage (see **12.1.7.5**).

13.5.5 Craneage arrangements

NOTE See BS 7121-3 for guidance on the selection, siting and use of mobile cranes.

The climbing of a tower crane is often accomplished by using the crane being climbed to unload and handle all the equipment and components involved in the climbing operation. However site or programme constraints, or requirements for ties or internal climbing frame supports might dictate the use of additional cranes. These may be either existing cranes on the site, tower or mobile, or mobile cranes brought onto site specifically for the climbing operation. In all cases the lifting operations should be planned by the Appointed Person. In the case of mobile cranes particular attention should be paid to positioning the crane and ensuring that the ground has sufficient capacity to safely absorb the loads imposed by the crane's wheels and outriggers.

13.5.6 Assembly and inspection of climbing equipment

Once the climbing equipment, either an external climbing frame or internal climbing collars and ladders, has arrived on site it should be inspected to ensure that damage has not occurred during transport and offloading. It should then be assembled in accordance with the manufacturer's instructions, before installation on the crane. Once installed around the crane tower the equipment should be inspected again to ensure that it is complete and ready for use.

The tower sections should be checked before use to ensure that they are of the correct type for the particular crane.

13.5.7 Positioning of tower sections

Tower sections that are to be incorporated into the tower during the climbing process should be positioned in a line away from the base of

the tower, normal to the open side of the climbing frame. This avoids the need for slewing during climbing.

13.5.8 Following manufacturer's procedures

It is important that the manufacturer's procedures for climbing equipment are adhered to. Whilst most tower crane climbing systems are based on the same principles, the details vary widely between makes and models and it is essential that the specific procedures for the exact climbing equipment type and crane configuration are followed. The assumption that a procedure for a similar looking crane can be safely followed should not be made.

It is also important that only components specified by the manufacturer are used in the climbing process.

13.5.9 Checks before and during climbing

There are a number of checks that should be made before starting and during the climbing process to ensure that the climbing equipment is correctly installed and fully operational.

These should include checks that:

a) the power supply cable has sufficient spare length to accommodate the increase in the crane's height;

b) the hydraulic power pack relief valve is set at the correct pressure for the crane configuration;

c) the foot of the hydraulic cylinder(s) reacting on the tower is correctly located on the reaction points;

d) the foot of any ratchet mechanism used to support the superstructure temporarily between strokes of a multi stage cylinder(s) is correctly located on the reaction points;

e) the tower section joints are correctly aligned before a new section is lowered onto the previous section;

f) hand held radios are in working order with fully charged batteries;

g) any system to prevent slewing of the superstructure during climbing is functioning correctly;

h) the crane superstructure is balanced;

i) the climb can take place within the wind speed limits set by the manufacturer;

j) arrangements are in place to ensure that the operator cannot inadvertently slew the crane;

k) after lowering the crane top the foot of the hydraulic cylinder(s) reacting on the tower remains correctly located on the reaction points.

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13.5.10 Balancing the crane

Before starting to lift the superstructure of the crane, in the case of external climbing, or lifting the complete crane, in the case of internal climbing, the crane should be "balanced" to ensure that the centre of gravity of the crane components being supported by the climbing equipment is over the centre of the climbing cylinder(s). This ensures that the climbing equipment is operated within its design criteria. The procedure for balancing varies with the type and model of crane, but generally consists of placing the movable components of the crane superstructure (luffing jib or trolley) at a specified radius, with or without a weight on the hook, in accordance with the manufacturer's instructions.

The manufacturer's instructions should include a procedure for establishing that the crane is in balance. This should be strictly adhered to. The balance of the crane should be checked before each extension of the climbing equipment.

A tolerance for the balance radius should be obtained either from the manufacturer or if the manufacturer is no longer available, from a competent engineer. If balance cannot be achieved within this tolerance climbing should be stopped whilst expert advice is sought.

NOTE Tolerance figure are typically within the range +/– 2 m.

13.5.11 Climbing in new tower sections

Once the crane has been balanced, the climbing equipment should be extended and new tower sections inserted, in accordance with the manufacturer's instructions. The climbing process should be repeated until the required number of sections have been added to the crane tower.

13.5.12 Re-commissioning the crane

Once the climbing process has been completed and the thorough examination carried out (see **13.7**) the crane should be returned to its working configuration and handed back to the user. This handover of the climbed crane should be recorded in writing so that it is clear to all parties that the crane may be used for normal lifting operations.

13.5.13 Storage and removal of the climbing equipment

Internal climbing equipment is normally left in place between climbs as it forms part of the support arrangements for the crane during normal working.

External climbing frames may either be removed after each climbing operation for use on another crane or left on the crane tower. Removal of the climbing frame should be planned as part of the climbing operation. If the frame is to be left on the tower between climbing operations this should be done in accordance with the manufacturer's instructions, taking into account any possible increases in wind loading etc.

13.5.14 Climbing down

Climbing down is generally the reverse of the climbing process, requiring the same planning and preparation as climbing up. If a crane that is tied to an adjacent structure is being climbed down, particular attention should be paid to ensuring that the crane is left in a suitable configuration at the end of each day or climbing shift to avoid excessive tie or tower forces in the out-of-service condition.

13.5.15 Contingency arrangements

The safety of tower crane climbing operations depends on keeping within a number of set parameters such as tower verticality, wind speed, crane balance and slew orientation throughout the operation. To avoid going outside these parameters arrangements should be put in place to deal with events such as, but not limited to, increase in wind speed, change of wind direction, gusting, electrical power failure, hydraulic and mechanical breakdown.

All possible events should be included in the risk assessment and contingency arrangements drawn up and recorded in the method statement. See **12.1.7.19** and **13.4.4.6**.

13.6 Thorough examination including testing of the crane after climbing

After each climbing operation has been completed, and before the crane is returned to service, it should be thoroughly examined and tested in accordance with the relevant clauses of BS 7121-2.

On completion of the test any load limits altered to facilitate the test should be reset to the rated load and a thorough examination of the crane should be carried out. The competent person should issue a report of thorough examination with an appropriate test certificate appended to it.

13.7 Maintenance of climbing equipment

13.7.1 General

The effective maintenance of climbing equipment plays a significant part in the safe and efficient completion of tower crane climbing operations.

13.7.2 Records

A full record of all use and maintenance, including checks and inspections, should be kept to ensure that a full history of the equipment is available.

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13.7.3 Checks and inspections

Pre-use checks and inspections of the climbing equipment should be carried out in accordance with the manufacturer's instructions, and should include the following as a minimum:

a) an inspection of the equipment in the workshop before transport to site;

b) an inspection of the equipment on arrival at site;

c) an inspection check of the equipment after assembly;

d) a pre-use check of the equipment at the start of each shift;

e) checks during the climbing operation.

13.7.4 Defect reporting

The erection supervisor in charge of each climbing operation should report any defects in the equipment to his manager so that the defects can be rectified before the next use of the equipment.

13.7.5 Thorough examination

Climbing frames, whilst not always part of the crane's permanent equipment, are devices for lifting persons and should be thoroughly examined either in accordance with a scheme of examination or at intervals not exceeding six months.

NOTE Further advice on the extent of examination of these devices is given in Annex D.

13.7.6 Maintenance intervals and procedures

Maintenance of both internal and external climbing equipment, including the servicing of hydraulic systems, should be carried out at the intervals and to the procedures prescribed by the manufacturer.

NOTE Heavy usage of the climbing equipment or usage in harsh environments might require maintenance activities to be carried out at more frequent intervals.

14 Procedures and precautions

14.1 Crane operation

Whenever a crane is moved, whether or not it is lifting a load, it should only be driven by a competent operator (see **8.4**) nominated by the appointed person.

This should not inhibit the appointed person from nominating a trainee operator provided that such an operator is under the direct supervision of a competent operator who has also been nominated for that purpose by the appointed person.

Maintenance/installation personnel who are required to move cranes during maintenance/installation work and thorough examination/testing should be competent and trained in crane driving to the extent necessary to enable them to carry out their duties safely.

*NOTE Special arrangements might be necessary when carrying out maintenance or repairs on the crane (see **14.2** and Clause **17**).*

14.2 Working on cranes

14.2.1 General

When personnel are required to work on cranes for inspection, maintenance or other reasons, a system should be in operation to ensure that:

a) they are not endangered by movement of the crane;

b) a safe working place and access is provided.

NOTE Attention is drawn to the Work at Height Regulations [14] regarding the provision of a safe working place.

For small and simple cranes where the operator has a clear view of all the moving parts, the system may be by means of verbal communication provided that it is clearly defined and readily understood by all personnel. For larger and more complex cranes a permit to work system may be necessary.

14.2.2 Permit to work

An effective permit to work system is intended to ensure that the crane is physically incapable of movement (by removal of fuses or by some other means) before written authority is given to the person who is to undertake the work. The system requires a specifically designed form or certificate to be issued only when the safety precautions necessary to achieve the safe system of work have been taken.

The recipient of the permit to work should sign the document and take it into safe custody understanding that he is responsible for the work and the personnel associated with that work. Upon completion of the work, the person who has been responsible for the work should sign the clearance section of the form or certificate certifying that all personnel have been withdrawn, that all gear, tools and loose materials have been removed, that all guards have been replaced and that all safety devices are operating.

Following the clearance of the form or certificate and the cancellation by the issuer, the safety precautions taken can then be removed and the crane returned to its normal mode of operation.

To achieve and maintain a safe system of work for the implementation of a permit system several conditions need to be met and these should include the following:

a) allocation of responsibilities for co-ordinating, monitoring, issuing, receiving, clearing and cancelling permits to work;

b) clear identification of the crane and its associated plant and apparatus;

c) effective means of isolation and making it safe from all sources of danger;

d) secure means of retaining any keys, fuses or other devices essential for maintaining the isolation of plant and apparatus;

e) demarcation of, and any special precautions taken to maintain, a safe working area.

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14.2.3 Periodic checks

For information on periodic pre-use checks and in-service inspections when working on cranes, see BS 7121-2:2003, Clause **5** and BS 7121-2:2003, Clause **6**.

14.3 Crane not in regular use

In cases where a crane is not used for an extended period of time the user should ensure that the competent person specifies a special programme of pre-use checks, inspections and thorough examination before it is used. The extent and thoroughness of this programme depends not only on the length of the period that the crane was out of use but also on the location of the crane during this period. Cranes standing under cover or inside a workshop might require very little extra, cranes that have been out exposed to the weather and atmospheric pollution, etc. might require an extensive appraisal to ensure fitness for work. See BS 7121-2:2003, Clause **8** for further details.

14.4 Reporting of defects and incidents

The appointed person should ensure that there is an effective procedure for reporting defects and incidents. This procedure should include notification to the appointed person, recording of action taken to rectify any defects and clearance of the crane for further service.

This procedure should include the immediate notification of the following:

a) any defects found during daily or weekly checks;

b) defects found at any other time;

c) incidents or accidents, however slight;

d) shock loads, however they occur;

e) dangerous occurrences or reportable accidents.

NOTE Attention is drawn to RIDDOR [19] in relation to the reporting of defects and incidents.

The procedure should include provision for an examination by a competent person after any incident, whether or not a repair is necessary, to ensure that the crane is fit for further service.

*NOTE See also BS 7121-2:2003, **6.4** and BS 7121-2:2003, **9.13**.*

14.5 Working at heights

When working at heights with tower cranes, a safe system of work should be used (see **4.1**).

14.6 Leaving the crane unattended

It is essential that a crane operator is present when a load is suspended from a crane.

When a tower crane is to be left unattended for even a short period, it is essential that the following precautions are carried out.

a) Ensure no load is left on the hook, and all chains, slings, etc. are removed.

b) Put the crane out of service in accordance with the manufacturer's instructions.

NOTE 1 In nearly every case, this involves turning the jib downwind and taking some action to ensure that the slew brake is left off, so that the crane is free to slew in the wind.

NOTE 2 In the case of saddle jib cranes it is usual practice to bring the trolley or carriage to a minimum radius position. Tower crane jibs might infringe air space when left in the out-of-service condition.

c) Where a crane is out-of-service on a site where it can collide with another crane that is still working, measures are put in place to prevent collision.

d) In the case of luffing jib and similar cranes, observe the manufacturer's instructions concerning the angle of the jib for out-of-service purposes.

e) Secure rail travelling cranes to the rails, to make sure that in the event of a high wind the crane cannot be blown accidentally along the rails. When left for long periods (e.g. overnight), cut off the power supply to the crane and secure and lock the door of the cab.

f) When a power supply has to be maintained overnight for cab or control cabinet heaters, lights, etc., make separate arrangements for the isolation of the power supply to the machinery.

15 Operating conditions

15.1 Rated capacity

The rated capacity of a crane may only be exceeded when testing the crane under the supervision of a competent person. The rated capacity of any item used to attach a load to a crane may only be exceeded when testing the item under the supervision of a competent person.

Care should be taken to prevent pendulum swinging of the load, by careful control of the operating motions to match the swing of the load and to keep it under control at all times.

Rated capacities apply only to freely suspended loads. The hoisting, slewing, traversing, luffing or travelling motions of a crane should not be used to drag any load along the ground with the hoist rope out of the vertical position. Before lifting a load, the hoist line should be plumb. Failure to observe these points can adversely affect the stability of the crane or introduce loadings (stresses) into the crane for which it has not been designed and, even with a rated capacity indicator/limiter fitted, a structural failure can result without warning.

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15.2 Mode of operation and control

15.2.1 General

To ensure safe use of the crane, each control should be marked to identify the motion controlled and the direction of movement. Markings should either be in the appropriate language(s) or consist of internationally agreed symbols (see ISO 7296-1) which should be adequately maintained.

It is essential the operator does not tamper with any controls, mechanisms or equipment, including limiting and indicating devices, either to enable the crane to function outside the operational range or loads specified by the crane manufacturer or other competent person, or to attempt to correct any suspected defect.

Before starting any lifting operation with a crane the crane operator should:

a) be trained and deemed competent on the particular crane;

b) have a clear and unrestricted view of the load and operational area or act under the directions of a slinger or an authorized signaller who is positioned to have a clear and uninterrupted view. The operator should also be in a position to receive warnings from any indicating devices;

c) ensure that lifts can be carried out without causing damage and that loads and crane hoist ropes are suitably clear of obstructions;

d) ensure that verbal messages can be clearly heard, especially where telephone, radio or closed-circuit television communications are being used.

The hoist rope should be vertical at the start of and throughout the hoisting operation. The load should initially be lifted just clear of the supporting surface and be brought to rest while the slings, balance of the load, etc. are checked, before proceeding. Care should be exercised by the operator at all times to avoid shock or side loadings on the jib or structure. Care should also be taken to avoid the hook or lifting accessories coming into contact with the structure.

Motion motors should only be reversed before the motor has come to rest when the control gear is specifically designed to allow this.

The crane safety devices should not be regarded as routine means of stopping the motion(s).

Before any crane is moved along its track(s), a warning should be given to all personnel who might be endangered. A warning bell or klaxon may be fitted for this purpose.

15.2.2 Remote-controlled cranes

NOTE Specifications for cableless controls and control systems are given in BS EN 13557:2003, Annex C.

To prevent unauthorized use, the operator of a crane that is controlled by transmitted signals, e.g. radio, should either retain the transmitter in their physical possession or remove the key from its key-lock switch and, for short periods, retain the key in their possession. For longer periods, or when the crane is not in use, the transmitter should be deposited in safe storage. Provision should be made for the security of the transmitter when the crane is not in use.

When the transmitter is fitted with a belt or harness, the operator should be wearing the harness before switching on the transmitter so that accidental operation of the crane is prevented. The transmitter should only be switched on when operating the crane and be switched off before removing the harness.

Where it is provided on a remote-controlled crane, the operator should test the controlled-range feature at regular intervals. The controlled-range feature should also either be checked at the beginning of each shift or whenever there is a change of operator to ensure that it operates within the limits specified.

15.3 Handling of loads near persons

When loads have to be handled in the vicinity of persons, extreme care should be exercised and adequate clearances allowed. The route of the load should be planned to prevent lifting over persons. Operators and signallers should pay particular attention to possible dangers of persons working out of sight.

All persons should be instructed to stand clear of the load being lifted. When lifting a load from a stack, all persons should be instructed to stand away from the stack in case adjacent materials or objects are displaced.

Where possible lifting of loads over highways, railways, rivers or other places to which the public have access should be avoided. If this is not possible, permission should be obtained from the appropriate authority and the area kept clear of traffic and persons.

15.4 Multiple lifting

Tower cranes should not be used for multiple lifts.

15.5 Special duties

Tower cranes should not be used for carrying out special duties such as grabbing, lifting by magnet, balling operations, pile driving, or extracting.

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16 Slinging and handling of loads

16.1 Weight and centre of gravity of the load

16.1.1 Weight of the load

It is essential that the weight of the load to be lifted is known to a reasonable accuracy. The weight should be determined by any of the following procedures.

a) Look to see if the weight is marked on the load. If it is, check to ensure that it is the weight of all parts of the load (a machine tool, for example, might not include the drive motor).

b) Check the weight stated on any documentation.

c) Look at a drawing of the load. If the weight is marked, check in the same way as in item a) to ensure it includes all parts of the load.

d) If the load is still on a trailer or truck, use a weighbridge.

e) Estimate the weight of the load by using tables of weights. BS 4-1 gives the weight of rolled steel sections and Table 2 gives weights for other materials.

Table 2 **Weight of materials**

Material	**Weight** kg/m^3	**Weight** lb/ft^3
Aluminium	2 700	170
Brass	8 500	530
Brick	2 100	130
Coal	1 450	90
Copper	8 800	550
Concrete	2 400	150
Earth	1 600	100
Iron and Steel	7 700	480
Lead	11 200	700
Magnesium	1 750	110
Oil	800	50
Paper	1 120	70
Water	1 000	62
Wood	800	50

NOTE 1 In some cases the values given are an average and the actual weight could vary according to the particular composition/water content, etc.

NOTE 2 All values have been rounded for convenience of use.

NOTE 3 When dealing with a hollow body, check whether or not it contains anything and whether or not any such contents are liable to move.

16.1.2 Centre of gravity

It is essential that the centre of gravity of the load is known. This is the point at which the total weight of the load is regarded as being concentrated, i.e. the point about which the parts of the load exactly balance each other.

16.1.3 Regularly shaped load(s)

With a regularly shaped load (for example a rolled steel joist), the centre of gravity can be easily judged by measuring the midpoint in each direction.

16.1.4 More complex-shaped loads or irregularly shaped loads

For more complex-shaped loads, it might be necessary to estimate the centre of gravity of the various parts of the load and then combine them to get a centre of gravity for the whole.

16.1.5 Use of lifting accessories/attachments

NOTE *The* Code of practice for the safe use of lifting equipment *[20] provides further information regarding the selection and use of equipment. See also BS 6210, BS 6968 and BS 6166-3.*

Only slings and other lifting accessories/attachments for which a valid report of thorough examination (and if produced, a valid test certificate) has been issued within the previous six months or in accordance with a scheme of thorough examination should be used.

Lifting accessories/attachments should be clearly marked with the rated capacity and an identification number (for record purposes).

Lifting accessories/attachments should be visually inspected on each occasion before use.

When not in use such lifting accessories/attachments should be stored in secure dry conditions, preferably by hanging on a rack where they cannot get tangled, wet or contaminated by dirt, grease, concrete, etc.

Lifting accessories/attachments should be released from the store only on the instruction of a person in charge of them.

Under no circumstances should slings be knotted.

When used in connection with the handling of molten metal or slag, the rated capacity of all lifting accessories/attachments should be de-rated to half the normal rated capacity.

Checks should be made to ensure that the lifting accessories/attachments can withstand the environment in which they are to be used and that they have been protected from mechanical damage and other hazards such as heat, cold or corrosive substances.

Under no circumstances should chains be joined by means of bolts or wire and when shackles are used it is essential that the correct pins are fitted.

Lifting accessories/attachments should not be dragged along the ground or floor.

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16.2 Signalling systems

Copies of the code of hand signals shown in Figure 3 should be issued to all crane operators, slingers and other personnel involved in the carrying out of a lifting operation to ensure that a universal signalling code is used.

In situations where hand signals alone are inadequate, other forms of communication should be used, by means of either radio or telephone, to supplement the hand signal code.

When radio is used as a means of signalling, the channel selected should be kept clear of all other communications. All personnel involved in the signalling should be given a clear and unique call sign and all communications should be preceded by this call sign. The crane operator should not respond to any command that is not preceded by the given call sign.

During the carrying out of the lifting operation, hand signals and any voice instruction to the crane operator(s) should only be given by one person at a time.

In multiple tower crane installations it is essential to have an anti-collision radio system installed. This comprises of a separate radio in each tower crane cab operating on a unique frequency to allow open unimpeded communication between all tower crane operators. In the event of the jib or counter jib of one crane approaching the hoist rope of a higher crane the operator of the higher crane can immediately warn the operator of the lower crane.

Guidelines on radiocommunications for tower cranes are given in Information Sheet RA 195 published by the Office of Communications [21].

17 Maintenance

NOTE This clause also includes checks and inspections as part of maintenance.

17.1 General

Provision should be made to ensure that throughout its use the crane and other equipment used in the lifting operation are maintained in a satisfactory condition.

The appointed person should be satisfied that adequate information, e.g. manufacturer's instructions, is available and that the maintenance is carried out by trained and assessed as competent personnel who have adequate knowledge of the correct procedures. The frequency and extent of such maintenance should take account of all factors that affect the crane in carrying out its work.

The activities of personnel carrying out maintenance activities should be covered by a safe system of work (see Clause **10**).

17.2 Planned maintenance

To ensure safe and satisfactory operation of the crane, a properly planned maintenance system should be established and used.

Manufacturer's instruction manuals recommend that specific tasks be carried out at stated intervals, and these periods should not be exceeded. They also specify the lubrication points that require attention, the interval or frequency of greasing and oil changes and the grades and quality of lubricant to be used. Instruction manuals also cover other essential maintenance such as tightness of electrical connections, frequency for checking the security of fixing bolts, recommended torque settings, inspection and setting of clutches and brakes, and functional testing.

LOLER [1] requires a competent person to assess whether or not the crane is fit for service at the time of the thorough examination. The thorough examination does not cover the absolute legal requirements to ensure that the equipment is properly maintained. Therefore a more frequent inspection should be carried out that takes account of the frequency of use of the crane and the environmental conditions.

An effective planned maintenance system should recognize the possible need to prohibit the use of the crane until essential maintenance work is carried out.

In addition to any statutory requirements, a record should be kept for every crane, giving information on the major components used in the crane manufacture, e.g. rope diameters, lengths, construction and breaking loads, tyre sizes and ply ratings, make and model of motors, pumps, gear boxes, winches, drives, electrical and hydraulic equipment and switch-gear.

The availability and source of replacement items should be checked and noted in the record/technical file.

Consideration should be given, where appropriate, to stocking certain expendable items and other parts to minimize down time in the event of crane breakdown.

It is essential that the calibration of the crane's RCI/L is checked as part of the planned maintenance. See BS 7121-2:2003, **9.8** for further requirements.

17.3 Replacement components

Replacement components should be in accordance with the manufacturer's specification.

17.4 Use of special materials in crane construction

Modern cranes make extensive use of high tensile steels. When repairs are carried out to any parts of the crane structure, the correct procedure laid down by the manufacturer should be strictly followed to avoid changing the properties of the material.

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18 Thorough examination

NOTE This clause also includes testing as part of thorough examination.

18.1 General

BS 7121-2 gives comprehensive guidance on the thorough examination of cranes. In particular BS 7121-2:2003, Clause **15** provides specific guidance on the thorough examination and testing of tower cranes.

The thorough examination of tower cranes involves work at height in areas without full edge protection. The risk assessment for this activity might require the use of personal fall protection equipment, see BS 8437. In such cases means should be provided for rescue of persons in the event that a fall results in them being suspended at the end of a lanyard. The means should be chosen following a site specific risk assessment, ensuring that persons can be rescued promptly to prevent the onset of suspension trauma.

NOTE A number of proprietary systems are available for this purpose.

18.2 Age and utilization

Tower cranes are not designed for a high intensity of usage. If a crane has been subjected to such usage, consideration should be given to the use of non-destructive testing to detect possible fatigue cracking. The assistance of the manufacturer or design authority should be sought to determine the vulnerable parts of the structure.

Usage or storage of the crane in a corrosive environment can also cause deterioration of the crane structure and this might require more extensive examination.

Fatigue damage and corrosion are also likely to be present on older tower cranes, which might require more detailed examination and testing as described previously.

Older cranes might remain serviceable, but particular attention should be given to these aspects on cranes which are more than ten years old.

Annex A (normative) Additional recommendations for the installation and use of self-erecting tower cranes

A.1 General

Self-erecting tower cranes are becoming increasingly popular on small construction sites where the size of the project does not justify the installation of a conventional tower crane. The management of the installation and use of self-erecting tower cranes follows the same principles as other tower cranes, the details however, vary between the two generic types.

It is quite common for operators of self-erecting tower cranes to carry out other tasks associated with the crane such as installation, maintenance and slinging duties. In such cases it is essential that the operator has been suitably trained and assessed as competent to carry out these duties.

Extreme caution should be exercised when considering the use of self-erecting tower cranes in multi-crane situations, as the risk of collision between the structures of adjacent cranes is high.

A.2 Selection and minimum attributes of personnel

A.2.1 Duties of personnel

It is quite common for the operator of a self-erecting tower crane to carry out some or all of the installation procedures for the crane. These procedures might range from simply retracting or folding the jib before leaving the crane out of service, to initial installation on a site and subsequent movements and distmantling. Consequently crane operators should be appropriately trained and assessed for the tasks they are required to undertake. In the case of an operator who also carries out installation of a self-erecting tower crane, their duties are outlined in **7.2.3** and **7.2.7**.

A.2.2 Minimum attributes of personnel

Personnel should have the minumum attributes required for the type and level of task they are required to undertake. In the case of a crane operator who also carries out installation, slinging and maintenance tasks on self-erecting cranes, these attributes are covered by **8.4, 8.5, 8.7** and **8.8**.

A.2.3 Training of personnel

Training of personnel should be carried out in accordance with a recognized scheme such as the Construction Plant Competence Scheme (CPCS) administered by the Construction Industry Training Board (CITB).

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A.3 Remote controls

Self-erecting tower cranes are generally operated by remote controls. The benefit being that the operator can follow the load and might be able to keep it in sight from point of pick up to point of delivery. There are however a number of disadvantages to this which are highlighted in **9.5.7**.

A.4 Siting of bases of cranes

Self-erecting tower cranes generally use outriggers and jacks, rather than the bases of conventional tower cranes, to transfer loads from the crane structure onto the ground. Attention should therefore be paid to the assessment of ground conditions and the arrangements for load speading to reduce ground pressure to an acceptable level (see BS 7121-3:2000, Clause **9**).

A.5 Thorough examination (including testing)

Self-erecting tower cranes are often constructed, transported and used as complete assemblies, rather than being assembled on site from components as are conventional tower cranes. In this case they should be treated as mobile cranes for thorough examination in accordance with BS 7121-2:2003, Clause **13**.

Annex B (normative) Lifting of persons

B.1 General

Raising and lowering people by equipment that is not specifically designed for this purpose should only be carried out in exceptional circumstances, when it is not practicable to do so by other less hazardous means.

Careful planning should be carried out prior to each raising and lowering operation.

NOTE Attention is drawn to LOLER [1] regarding the planning of lifting operations.

B.2 Carrier

The type of carrier selected for the lifting of persons should depend on a risk assessment and may vary according to the application, for example construction, forestry, rescue.

B.3 Compatibility of carrier and crane

B.3.1 Capacity

The crane selected to lift the carrier should have a rated capacity on the hook of at least twice the minimum rated capacity of the crane configuration in use.

B.3.2 Motion control system

The crane should be equipped with a motion control system that brings motion to rest automatically when the controls are released.

The crane should be equipped with power lowering. Cranes with free-fall capability should not be used to lower and raise persons unless the free-fall facility is locked out.

Load bearing hydraulic cylinders should be fitted with a device to stop movement in case of hose rupture or pipe fracture.

The crane control system should be able to provide a smooth transition of the carrier. The working speed of the carrier should be limited to a maximum of 0.5 m/s on all motions.

Means should be provided so that if the power supply or control system fails, the carrier can be positioned to enable access/egress without risk.

B.3.3 Ropes

Ropes used for hoisting and lowering the carrier should have a diameter of at least 8 mm.

B.3.4 Hook

The crane hook should be provided with a safety catch.

B.4 Other devices

B.4.1 Anemometer

The crane should be fitted with an anemometer or other device to monitor in-service wind speeds.

B.4.2 Storage

Storage accommodation for equipment, including any emergency egress equipment (for example, safety harness, lanyard), should be provided in the carrier.

B.4.3 Rated capacity indicator/limiter

The rated capacity indicator/limiter on the crane should be maintained in good working order and used when the lifting of persons is undertaken.

Limit switches should be provided to prevent over-hoisting, over-lowering or over-derricking.

Limit switches should be checked for correct operation each day before personnel carrying operations are carried out. Limit switches are not necessarily fail safe and therefore care should be taken if motion limits are approached.

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A fail safe procedure should be provided to ensure that sufficient hoist rope remains on the winch drum at all times to prevent the end of the rope running off the drum while lowering the carrier. To ensure that sufficient rope remains on the drum at all times, the carrier should be lowered to the bottom of the shaft, cofferdam or caisson as follows:

a) the first time it is lowered;

b) after each time the shaft, cofferdam or caisson depth increases;

c) if the crane hoist rope is replaced.

Care should be taken when the crane is moved to different locations to ensure that sufficient rope is fitted for each operation.

Operation of limit switches, check valves and similar devices could prevent some motions of the crane with the carrier still suspended. Precautions should be taken to ensure that persons in the carrier are not left suspended for an excessive period, and/or a procedure for raising or lowering the carrier to a safe position should be provided.

B.5 Operation

B.5.1 Organizational recommendations

Lifting, lowering and supporting the carrier should be carried out in controlled conditions directed by an appointed signaller.

The crane operator should be present at the normal crane control station when the carrier is occupied. Visible and audible communication should be possible between the persons in the carrier and the crane operator at all times during the lifting operation.

During the operation:

a) a person should be present to perform any emergency recovery procedure;

b) the crane operator and signaller should not perform any other work at the same time. The crane operator and signaller should only be responsible for operating one crane or directing one carrier;

c) machines should not operate simultaneously in the same place if there could be a risk of collision;

d) all movements should proceed gently and not exceed 0.5 m/s.

Lifting accessories for carriers should not be used for any other purpose.

Carriers should not be used in the following conditions:

1) winds exceeding 7 m/s (25 km/h), (windspeed measurements should be taken using a calibrated handheld anemometer at a similar level to that to which the carrier will be lifted);

2) electrical storms;

3) snow or ice;

4) fog;

5) sleet;

6) other weather conditions that could affect the safety of personnel.

Unintentional rotation of the carrier should be prevented, for example by using guide ropes or anchoring. The means of preventing unintentional rotation should not inhibit any emergency procedures and should not otherwise interfere with the safe operation of the carrier.

Carriers should not be occupied while the crane is travelling.

Lifts should not be made on any other hoist lines of the crane while any person occupies a carrier attached to the crane.

The crane, lifting accessories and carrier should be inspected every day during use.

B.5.2 Precautions for persons in the carrier

The payload of the carrier should not be exceeded.

The stability of the carrier should not be affected by the operation.

Additional care should be taken if the carrier is of a length that could lead to excessive tilting through movement of persons or tools within the carrier.

It is strongly recommended that all users of carriers wear suitable full body harnesses with work restraint systems attached to a suitable anchorage point in the carrier. The most suitable type of work restraint system is an adjustable lanyard, adjusted to be as short as possible to ensure that a person is restrained within the carrier. Further information on the use of personal fall protection equipment is given in BS 8437.

Consideration should be given to the rescue of persons from carriers if the carrier is unable to be lowered for any reason, such as machine malfunction or carrier entanglement. Any rescue procedure should be properly planned, taking into account the reasons why the carrier is stranded at height and any need for urgent action. In many circumstances the rescue plan simply involves lowering of the carrier by the supporting crane.

In the event that fall arrest equipment is selected a rescue plan is required as detailed above to avoid the consequences of suspension trauma when a person is suspended from a fall arrest harness.

Any tools/materials in the carrier should be secured to prevent displacement, tipping and/or falling out.

Personnel should remain entirely inside the carrier during raising, lowering and positioning to avoid pinch points. Personnel should only stand on or work from the floor of the carrier.

Carriers should be secured so that access and egress can be accomplished without danger.

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B.5.3 Work from a carrier

NOTE 1 Exposed electrical conductors in the vicinity of the lifting operation can present electrical hazards. Exposed high voltage conductors can cause electric shocks or burns even if not touched by personnel. If there are electrical conductors adjacent to the work area, seek advice from the owner of the conductor. Overhead lines usually belong to the local electricity supplier or the National Grid company. These suppliers can provide advice on safe working distances from electrical conductors.

If electric arc welding is carried out from a carrier, precautions should be taken to prevent stray welding return currents from flowing through the lifting accessories, crane hoist rope, or other part of the crane. Electric arc welding should be carried out in accordance with HS G 118 [22]. The return welding current lead should be secured to the welded part, as close as practicable to the point of the weld.

NOTE 2 Complete insulation of the crane hoist rope or use of clean dry webbing lifting attachments can also prevent stray currents.

Electric powered hand tools, if used, should be battery powered.

Power cables provided to the carrier should not interfere with safe operation of the carrier.

Power cables should not be used as steady lines.

Annex C (normative) Training of crane operators and slingers

C.1 General

The employment of competent, trained operators and slingers is one of the important factors in the safe use of cranes. Inadequate employee training is a contributory cause of crane accidents, which result not only in significant damage to plant, but also in severe injury to those doing the work or those nearby. Training enables suitable employees to learn the basic elements of crane driving and slinging which, with experience, help them to become competent.

These recommendations are relevant to work associated with conventional types of crane. Machines which can be converted to be used as cranes (e.g. fork lift trucks), which are particularly simple in operation (e.g. hoists used by machine operators) or are special in their design or use (e.g. lorry loaders) present different problems and are not covered.

Detailed information about the content of training courses varies depending on the individual circumstances, so the information given is intended to assist organizations, running training courses internally or as a service to other organizations, to determine whether their courses are adequate.

C.2 Employers duties

Training of personnel should be treated as an important element in the overall safe planning and supervision of lifting operations. Therefore employers should:

a) use appropriate procedures to ensure that suitable potential trainees are selected (see **C.4**);

b) provide adequate basic training in the principles of crane driving and slinging (see **C.5** and **C.8**);

c) train employees in the use of the particular equipment (cranes or lifting attachments) which they are expected to use, and instruct them in the jobs they are required to do and any particular hazards of the sites where they could work (see **C.7**);

d) use only authorized employees who have reached an adequate standard in their training and who show themselves to be competent (see **C.9**);

e) provide adequate supervision so that the competence of operators and slingers can be monitored and the need for any refresher training assessed.

C.3 Machine specific training

C.3.1 General

As cranes vary widely in the way they are operated and the circumstances in which they are used, the knowledge and expertise required by the operator varies accordingly. It should be recognized that an operator who is competent to operate one type of crane might not have the necessary knowledge and experience needed to operate other types.

C.3.2 Appropriate training

It is essential that training is related to the knowledge and experience of the operator, to likely job hazards, and to the size and complexity of the crane itself. For example, a small pendant operated overhead travelling crane used for a limited range of simple lifting operations is not likely to require a lengthy formal training course, while a large mobile crane capable of being used in different ways for various complex lifting operations and in different work locations, requires wider and more detailed training.

C.3.3 Slinger training

Similar principles should apply to the training of slingers; they need to be trained in safe lifting practices for possibly varying types of load.

C.3.4 Instructors

The success of any training depends largely on the effectiveness of the instructors. Training should be carried out by people who have been selected and trained for the purpose. To guide organizations who employ trainers (part-time or full-time), some information on their selection and training is given in **C.10**.

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C.4 Selection of operators and slingers

C.4.1 General

Potential operators and slingers should be carefully selected by the employer on the basis of appropriate criteria. Selection tests may be used as part of the process. Careful selection of employees before training starts helps to ensure that resources are not wasted.

C.4.2 Selection criteria

The criteria to be used when selecting potential crane operators or slingers include the following points.

a) The person should be reliable, with the ability to work in a responsible and safe manner. Some crane operators (e.g. for mobile cranes) might need an appropriate current driving licence. In general crane operators should be at least 18, although younger people might be sufficiently mature to be trained.

NOTE Attention is drawn to The Management of Health and Safety at Work Regulations as amended [9] which require crane operators to be over 18 unless they are under the direct supervision of a competent person for the purpose of training.

b) The person should be able to demonstrate an understanding of what is involved in safe operation. Some cranes have complex controls or require a detailed understanding of load charts, etc. Crane operators and slingers might need to estimate or calculate loads, assess angles and use charts. A reasonable level of mathematical and mechanical aptitude is therefore likely to be required.

c) The person should be able to demonstrate their fitness to do the job, both physically and mentally. People with handicaps or disabilities are not necessarily unable to work safely with cranes, but extra care might be needed in their selection. Where the employer has reason to believe medical advice might be needed about a person's suitability, it should be obtained.

C.4.3 Assessment of training needs

Following selection, or as part of it, an assessment should be made of the extent of training which is needed for an individual, bearing in mind that this could be influenced by any previous training and experience. When operators or slingers are recruited it is essential that employers check that their qualifications and experience relate to the job they are to do. Where the type of crane to be operated or the slinging procedures to be used are outside the employee's previous experience, additional training should be provided. In any event, some further training is likely to be necessary to familiarize the employee with specific requirements of the new job.

C.5 Basic training of operators

C.5.1 General

Basic training covers the principles, both theoretical and practical, governing the safe operation of a given type of crane.

A basic training course is usually designed with the requirements of novice operators in mind but it would be unwise to assume that more experienced employees do not need basic training. Many training organizations acknowledge this and run short courses for those with experience, recognizing that less time is necessary for training in the fundamental aspects. There are also short courses designed to judge the competence of an experienced operator. These can provide an assessment of skill, an opportunity for limited instruction in weak areas and a practical test of competence.

With such a wide range of cranes, employee experience and company requirements, some training organizations arrange for a basic course to be tailored to meet a client company's requirements. This should be discussed with them before the course commences. Similarly, those companies designing internal courses might wish to fit the basic course to their more special needs. It is desirable that the content of such courses matches the information provided by the employer.

C.5.2 Training venue

Training should be given either at a suitable training centre or at the employer's premises. Where it is given at the employer's premises it should (at least for the larger and more complex cranes) be carried out independently of the trainee's normal work. This means that the instructors and trainees together with the crane and loads should, during the basic training, be wholly devoted to that training.

C.5.3 Cranes used for training

A crane used for training should have similar characteristics to the type the trainee would normally use after training. It should be in good condition and safe for the particular operations covered.

C.5.4 Training area access

Where possible, access to the training area should, for safety reasons, be restricted to the instructor and trainees. If there is access by other people, e.g. when training on an overhead travelling crane is done in an occupied workshop, precautions should be taken to ensure that all personnel are made aware of the situation, the area is appropriately marked and people not involved in the training are adequately protected.

C.5.5 Appropriateness of training

As far as possible the training should include practice in the range of loads and conditions likely to be met by the trainees including any particular hazards met in normal operations. The employer should ensure that if another organization carries out the training it is made aware of the sort of work which the trainee is likely to be doing.

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C.5.6 Facilities and training aids

Suitable facilities and training aids should be available so that the instructor can cover the theory of crane operation under reasonable conditions.

C.5.7 Course duration

The course should be largely practical in nature and sufficiently long to enable trainees to master the necessary skills.

C.5.8 Course structure

The course should follow a carefully devised programme which ensures that each operation is introduced at an appropriate point in the course, building on what has gone before, allowing adequate time for learning and practice before moving on to subsequent operations. At each stage the instructor should explain and demonstrate the operation and trainees should then practice it under supervision.

The simpler tasks with less potential hazard should be dealt with first before progressing to more complex operations. Training in safe operation should be provided an as integral part of the course and not separately, nor should the course be altered to suit immediate operational requirements.

C.5.9 Multiple crane types

If there is a requirement to operate more than one type of crane, training should be given for each type and, although this would not normally require a re-run of the complete basic training course, it should cater for the differences between types of crane. Practical experience of each should be enough to enable the trainee to pass a test on each type.

C.5.10 Trainee/Instructor ratio

It is important that the ratio of instructors, machines and trainees suits the particular aspect of training being covered. There should be sufficient time for the instructor to demonstrate each part of the practical training and then for each trainee to practice the skills while also being able to learn from observing other trainees. While one instructor can deal with a number of trainees when teaching in a classroom, practical work should have a more individual approach.

C.6 The training programme

C.6.1 General

As a minimum the training programme should cover those subjects given in **C.6.2** and **C.6.3** which are relevant to the type of crane for which training is being given.

C.6.2 Theoretical topics

Theoretical topics should include:

a) an introduction to the course syllabus, with reasons for the importance of training;

b) the relevant legal requirements, including those to do with crane construction, maintenance, examination, certification and use and the different responsibilities of all the individuals involved with a lifting operation;

NOTE Reference could be made to relevant published material including British Standards and HSE or other guidance.

c) an introduction to cranes, explaining the purpose of all main components, including the location and function of controls, instruments, indicators and safety devices;

d) principles of mechanical, hydraulic, pneumatic and electrical systems as they are relevant to the safe operation of cranes;

e) routine inspection, reporting, servicing, maintenance, erection and dismantling in accordance with manufacturer's instructions, detailing those tasks which are generally within the trainee's responsibilities;

f) limitations on the uses of cranes including the relevance of the strength and stability of cranes, ground conditions, the distribution of the total load (i.e. the load being lifted and the load due to the equipment's weight) through the supports, e.g. outriggers or building structures, and dynamic, e.g. shock, wind, etc., loadings;

g) assessment of loads, including estimation of weights and centres of gravity, and their stability;

h) good operating practices including operation near other cranes, precautions near overhead lines, structures, etc., and multiple lifting;

i) signalling methods including the recognized code of manual signals (see Figure 3);

j) maintenance of relevant records including, if appropriate, the relevant statutory forms.

C.6.3 Practical topics

Practical topics should include:

a) routine inspection, maintenance and reporting of defects and, where necessary, completion of relevant records;

b) if relevant to the type of crane, travel without a load, both between sites and, where erected, at the worksite;

c) siting of cranes and preparation of the ground and crane for lifting;

d) assessment of loads, crane lifting duties and selection of correct cranes and lifting accessories;

e) elementary operation of all controls under "no-load" conditions;

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f) using the crane to lift and position loads in progressively more demanding situations, both for the crane and the operator, using as many configurations of the crane as is practicable, including travelling with a load and, if appropriate, multiple lifting and use near structures;

g) practice in working with a signaller;

h) use and testing of safety devices;

i) use of emergency escape devices where fitted;

j) erection and dismantling of the crane as necessary and as is within the responsibility of the trainee;

k) procedures for isolating the crane for maintenance etc. including the proper use of permits-to-work where appropriate to the type of crane.

C.6.4 Training in slinging

Most operators should also be given training in slinging (see **C.8**) either because they need an appreciation of those skills or because they are likely to be acting as the slinger as well as operating the crane.

C.7 Advanced training for operators

C.7.1 General

Advanced training of operators should follow the completion of basic training. It should be tailored to the employer's needs and include the following elements.

a) Instruction in the operating principles and controls of the specific crane(s) to be used, especially where these relate to special attachments and loads. Also details of the routine inspection and servicing of the equipment in accordance with the manufacturer's handbook or instructions, to the extent that is the employee's responsibility.

b) Training in using the equipment in the conditions the operator is likely to meet on the job, and on the particular work to be undertaken.

C.7.2 Training venue and course content

Advanced training should either be carried out on the employer's or in some cases the manufacturer's premises, and include the application, under normal working conditions, of the skills learned during the first stages. It should be carried out under supervision. The training should include particular information on site layout, emergency procedures and any other matter which it is not practicable to teach "off-the-job".

C.8 Training of slingers

C.8.1 General

The training of slingers (who may also be operators) should provide information and practical experience on the principles of care, maintenance, selection and use of lifting accessories.

C.8.2 Training focus

The trainees and instructors should, during the training, be solely concerned with that training.

C.8.3 Training equipment

There should be a good range of lifting accessories available including, where possible, any special purpose lifting accessories which the employee is likely to use. The lifting accessories should be in good condition and safe for whatever operations are being covered.

C.8.4 Training facilities

Suitable facilities and training aids should be made available so that the instructor can cover the theoretical parts of the training. Courses should however be as practically based as possible.

C.8.5 Course duration

While courses for slingers often do not need to be very long, sufficient time should be available to cover the subject adequately and to allow time for practical work.

C.8.6 Course content

C.8.6.1 Theoretical topics

Theoretical topics should include:

a) introduction to the course syllabus, with reasons for training;

b) relevant legal requirements and published guidance material;

c) introduction to the different types of lifting accessories, their functions, limitations and reasons for possible failure;

d) routine care, inspection, maintenance and reporting of defects. Information should be given on the criteria for rejection (although it is not expected that the trainees would have sufficient knowledge or experience to be able to act as competent persons to carry out thorough examinations);

e) assessment of loads, including estimation of weights and centres of gravity;

f) selection, correct use and practice in the use of appropriate lifting accessories, including methods of slinging, the methods of rating for multi-legged slings, the concepts of working load limit and safe working load, interpretation of markings and de-rating of lifting accessories for any particular adverse conditions of use;

g) signalling methods, including the recognized code of manual signals;

h) record keeping to the extent that it is the slingers' responsibility.

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C.8.6.2 Practical topics

Practical topics should include:

a) practical work on selecting lifting accessories for particular loads;

b) where signalling is included, giving appropriate signals to a crane operator;

c) particular hazards or situations which the employee is likely to meet in the normal job.

C.9 Appraisal and authorization

C.9.1 General

Continuous assessment of trainees' progress should be made by the instructor during training to ensure the required standards are reached at each stage.

C.9.2 Crane operator's test

At the end of the training programme, crane operators should take a test (which may be partly written) to determine their ability to perform the following tasks satisfactorily.

a) Routine maintenance, safety checks and inspections and completion of records.

b) Proper siting of the crane and use of out-riggers, etc.

c) If relevant, setting up, erection and dismantling of the crane.

d) Use and testing of safety devices.

e) Handling different loads in a variety of conditions and, if appropriate, crane configurations.

f) Use of correct and adequate signalling techniques (see Figure 3).

g) Description of emergency procedures.

C.9.3 Slinger's test

Slingers should also be assessed by means of a suitable test which confirms their ability to perform their duties satisfactorily.

C.9.4 Training records and certification

Trainees who have satisfactorily completed a training course should be awarded a certificate to that effect. Where training has been given in a number of stages in particular, the employee, or employer on their behalf, should keep a record of what training has been carried out.

C.9.5 Authorization of employees

Employers should give specific authorization to employees to drive cranes and/or act as slingers. Employers should be satisfied that the employee has had appropriate training and is competent to do the job. Where the crane is simple to operate and there is not likely to be confusion as to who is authorized, this authorization need not be in writing. However, where the tasks are complex and the crane operator needs to be highly competent, there should be a formal written authorization which makes it clear who may carry out the job. The authorization for slingers might be contained in their job description or similar document as long as there is no confusion about who may do the job.

C.9.6 Continuing assessment

Even after training has been completed and authorization given, a periodic assessment of personnel should be carried out to determine continued competence. Refresher training might be appropriate.

C.10 Selection and training of instructors

C.10.1 General

Training should be carried out by instructors who are competent, carefully selected and trained for the purpose.

C.10.2 Previous experience

As training contains a lot of practical work, instructors should be competent and experienced in the use of the relevant equipment.

C.10.3 Instructor qualities

In addition to operating competence, an instructor should have the motivation to be an instructor and the ability to communicate effectively, to be able to lead and control and to be responsive to the varying needs of different trainees.

C.10.4 Instructor training course content

Instructors' training should cover at least the following topics.

a) Principles of instruction, including classroom techniques and practice demonstration techniques.

b) Assessment and analysis of work activities in order to set a training specification in an objective form.

c) Course design, to meet the training specification devised in list item b).

d) Design, construction and use of practical tests to assess trainees' performance.

C.10.5 Assessment and certification

Instructors should be assessed and issued with a certificate if they have reached a satisfactory standard of effectiveness. Their competency as instructors should be reviewed periodically and refresher training given if needed.

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Annex D (informative) Example of typical procedure for climbing frame thorough examinations and checks

D.1 Procedure for the thorough examination of frame for top climbing of tower cranes

D.1.1 Procedure for 6 monthly thorough examination

NOTE The 6 monthly thorough examination may be supplemented by NDT examination at the discretion of the competent person.

D.1.1.1 Confirm the identification number of the frame and all corresponding sections, to confirm all parts are of the same frame.

D.1.1.2 Carry out a visual check of the frame structure, checking for any damage to structural members or evidence of cracking in welds. Pay particular attention to the suspension brackets and the jointing plates.

D.1.1.3 Confirm the free movement of all guide rollers and check for damage.

D.1.1.4 Check the rollers for undue wear and check that all keep plates are in place and secure.

D.1.1.5 Check the hydraulic ram mounting brackets for security and check the welds for signs of cracking.

D.1.1.6 Check the lifting yoke at the base of the hydraulic ram for signs of wear and any cracking or deformity.

D.1.1.7 Check the hydraulic ram joint pin for lift and that it is correctly locked in position.

D.1.1.8 Check that the rollers, to allow horizontal motion of the ram, are free to rotate.

D.1.1.9 Carry out a visual inspection to check that the hydraulic system is free from leaks and has no damage to the pipework or the connections.

D.1.1.10 Check the travelling platform for damage to itself and its supports.

D.1.1.11 Check the walkways for damage and security of fixing. Close off the walkways.

D.1.1.12 Record the results of the examination on the appropriate form and retain on file.

D.1.2 Procedure for 2 yearly thorough examination

NOTE This work is to be carried out with the frame on the ground at rest.

D.1.2.1 Carefully examine the main load bearing parts and subject them to NDT examination as necessary. The examination should include the following:

- the jointing plates and associated supporting structures;
- the reaction roller supports and associated structures;
- the main suspension lugs;
- the corner nodes;
- the main lifting yoke.

D.1.2.2 Remove the reaction roller pins and measure them to assess wear. Subject the pins to NDT examination.

D.1.2.3 Carry out the six monthly thorough examination at this time.

D.1.3 Procedure for 4 yearly thorough examination

NOTE This work is to be carried out with the frame on the ground at rest.

D.1.3.1 Subject the hydraulic ram and relief valves to a pressure test in accordance with the manufacturer's recommendations for that system.

D.1.3.2 Remove the ram-jointing pin, measure it for any wear, and subject it to NDT examination.

D.1.3.3 Carry out the 6 monthly thorough examination at this time.

D.2 Procedure for post installation thorough examination report

NOTE The post installation thorough examination may be supplemented by NDT examination at the discretion of the competent person.

D.2.1 Confirm the identification number of the frame and all corresponding sections to confirm all parts are of the same frame.

D.2.2 Carry out a visual check of the frame structure, checking for any damage to structural members or evidence of cracking in welds. Pay particular attention to the suspension brackets and the jointing plates.

D.2.3 Confirm the free movement of all guide rollers and check for damage.

D.2.4 Check the rollers for undue wear and check that all keep plates are in place and secure.

D.2.5 Check the hydraulic ram mounting brackets for security and check the welds for signs of cracking.

D.2.6 Check the lifting yolk at the base of the hydraulic ram for signs of wear and any cracking or deformity.

D.2.7 Check the hydraulic ram joint pin for lift and that it is correctly locked in position.

D.2.8 Check that the rollers, to allow horizontal motion of the ram, are free to rotate.

D.2.9 Carry out a visual inspection to check that the hydraulic system is free from leaks and has no damage to the pipework or the connections.

D.2.10 Check the travelling platform for damage to itself and its supports.

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D.2.11 Check the walkways for damage and security of fixing. Close off the walkways.

D.2.12 Record the results of the examination on the appropriate form and retain whilst the frame is installed for use at that location.

D.3 Procedure for pre-use check of frame for top climbing of tower cranes

D.3.1 Confirm that the frame has current thorough examination and installation reports.

D.3.2 Confirm that the test of the hydraulic system is current.

D.3.3 Confirm that all personnel have been issued with a copy of this procedure or a checklist that relates to it.

D.3.4 Confirm that all personnel are trained in the operation and understand the procedure.

D.3.5 Confirm that communication either by radio or telephone is available.

D.3.6 Examine all connecting pins/bolts prior to erection to determine whether they are the correct type and undamaged.

D.3.7 Check the frame to ensure the jointing bolts are in place and secure.

D.3.8 Check the main guide roller pin keep plates are in place and secure.

D.3.9 Check the walkways are secure with no missing bolts or guardrails.

D.3.10 Check that the hydraulic system is free from leaks.

D.3.11 Check the apron for the support of the section to be inserted is secure and free to move.

D.3.12 Engage the slew lock or physically lock the slew and inform the operator of the importance of maintaining this action.

D.3.13 Obtain authorization of the checklist and permit to climb from an appointed person at the site.

Annex E (informative) Background to the BS 7121 series

The misuse of cranes through lack of knowledge and understanding of hazards and/or safe working procedures is a major cause of accidents. This code of practice therefore aims to:

a) describe the principal characteristics of the various forms of cranes of the types most commonly used;

b) draw attention to some of the more common hazards and potential dangers which might be encountered in their use;

c) recommend general precautions to be taken and procedures to be followed to avoid accidents;

d) implement legislation by providing guidance drawn together by expert parties on good practice in the use of various types of cranes.

These codes of practice have been prepared by Committees of representatives from different branches of the crane industry and the HSE. Their combined experience and specialist knowledge in the fields of crane design, manufacture, application and safety ensure that the recommendations are well founded and practical.

For over 28 years UK experts have worked together codifying recommendations to address these issues that have been adopted and used by the crane industry.

It has long been recognized by the Committees that the safe use of a crane ultimately rests with the operational personnel taking account of manufacturers/suppliers information.

Committee members are unanimous in their view that there is a need for the introduction of national systems, e.g. for licensing crane operators to operate only those types of cranes for which they have received training and have demonstrated their competence.

Management have the overall responsibility for safety and supervision and it is to management that these codes of practice are primarily directed.

The intention is that these codes are used by management both as a working guide and in the training of personnel in safe working practices, and that appropriate information and recommendations are incorporated in their company standing instructions for the safe use of cranes.

These recommendations were originally published before LOLER was written and it is worth noting that the guidance published by the HSE in support of LOLER makes eight references to the BS 7121 series.

The Health and Safety at Work etc. Act 1974 [5] requires duty holders to have in place safe systems for all work activities. The systems require adequate:

1) planning;

2) management and supervision;

3) training of personnel;

4) clear instructions.

The BS 7121 series has been accepted as representing the consensus of practical experience for safety on cranes. Therefore as far as safe crane operations are concerned, the benchmark for safe working practices is the BS 7121 series.

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